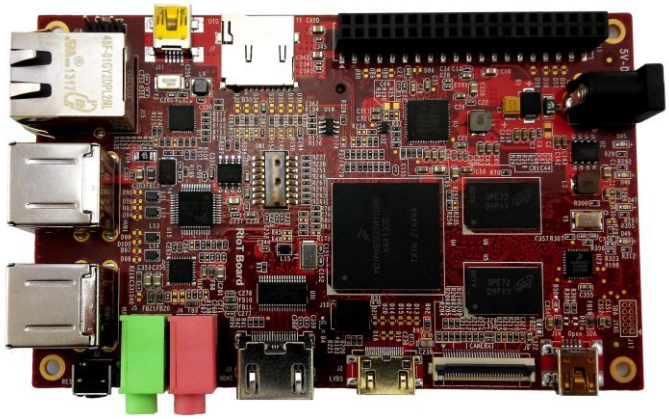
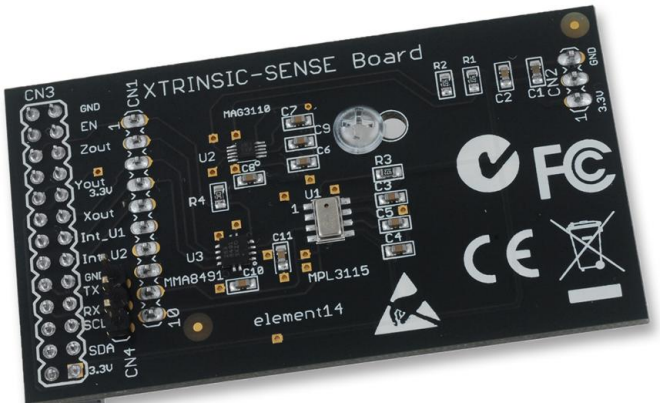
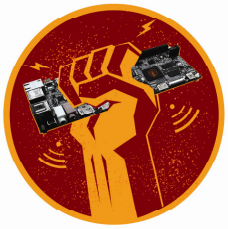
RIoTboard Web Server Master Class
Hardware Kit User Manual





<u>This document contains:</u>

- RIoTboard User Manual v1.0
- XTRINSIC-SENSE Board User Manual



RIoTboard

Revolutionizing the Internet of Things

Table of Contents

1 BOARD OVERVIEW 7

1.1 PRODUCT INTRODUCTION 7

1.2 FEATURES 8

2 HARDWARE DESCRIPTION 11

2.1 PROCESSOR 11

2.1.1 Core Features 11

2.1.2 External memory interfaces: 12

2.1.3 Interface to external devices 13

2.1.4 Advanced Power Management unit 14

2.1.5 Hardware Accelerators 14

2.2 EXPANDED CHIP INTRODUCTION 15

2.2.1 MT41K256M16HA-125:E 15

2.2.2 MMPF0100NPAEP 15

2.2.3 AR8035 15

2.2.4 FE1.1 16

2.2.5 SGTL5000 16

2.3 EXPANDED CHIP INTRODUCTION 17

2.3.1 Power Input Jack 17

2.3.2 LVDS Interface 18

2.3.3 HDMI Interface 19

2.3.4 Microphone Input Jack 21

2.3.5 Audio Output Jack 22

2.3.6 SD Card Interface 23

2.3.7 uSD/MMC Card Interface 24

2.3.8 CSI Interface 25

2.3.9 Camera Interface 26

2.3.10 JTAG Interface *28*
2.3.11 Mini USB Interface *29*
2.3.12 Serial Port *30*
2.3.13 Expansion Port Interface *31*
2.3.14 Mini USB Interface (OpenSDA) *33*
2.3.15 RGMII LAN Interface *34*
2.3.16 USB HUB Interface *35*
2.3.17 Boot Configuration Select *36*
2.3.18 Reset Switch *38*
2.3.19 LEDs *39*

3 GETTING STARTED 40

3.1 SOFTWARE FEATURES 40
3.2 LINUX SYSTEM 40
3.3 ANDROID SYSTEM 41
3.4 SETTING UP TERMINAL EMULATION 42

4 DOWNLOADING AND RUNNING THE SYSTEM 43

4.1 DOWNLOAD AND RUN LINUX OR ANDROID SYSTEM 43
4.2 DISPLAY MODE CONFIGURATIONS FOR LINUX & ANDROID SYSTEMS 46

5 MAKING IMAGES 48

5.1 MAKING IMAGES FOR LINUX 48
5.1.1 Getting Tools and Source Code *48*
5.1.2 Compiling System Images *48*
5.2 MAKING IMAGES FOR AN ANDROID SYSTEM 49
5.2.1 Getting Repo Source Code *49*
5.2.2 Compiling System Images *50*

6 ESD PRECAUTIONS AND PROPER HANDLING PROCEDURES 52

LIST OF FIGURES

Figure 1-1 Functional Block Diagram 7

Figure 1-2 RIoTboard top view 8

Figure 1-3 RIoTboard bottom view 9

Figure 2-1 Block Diagram of i.MX 6Solo 12

Figure 2-2 Power Interface 17

Figure 2-3 LVDS Interface 18

Figure 2-4 HDMI Interface 19

Figure 2-5 MIC Input 21

Figure 2-6 Audio Output Jack 22

Figure 2-7 SD Card Interface 23

Figure 2-8 uSD/MMC Card Interface 24

Figure 2-9 CSI Interface 25

Figure 2-10 Camera Interface 26

Figure 2-11 JTAG Interface 28

Figure 2-12 Mini USB Interface 29

Figure 2-13 Serial Port 30

Figure 2-14 Expansion Port 31

Figure 2-15 Mini USB (OpenSDA)Interface 33

Figure 2-16 RGMII LAN Interface 34

Figure 2-17 USB Host Interface 35

Figure 2-18 Boot Configuration Select 36

Figure 2-19 Reset Switch 38

Figure 2-20 LEDs 39

Figure 3-1 COM Properties 42

Figure 4-1 Boot Configuration Switch 43

LIST OF TABLES

Table 2-1 Power Interface 17

Table 2-2 LVDS Interface 18

Table 2-3 HDMI Interface 19

Table 2-4 MIC Input Jack 21

Table 2-5 Audio Output Jack 22

Table 2-6 SD Card Interface 23

Table 2-7 uSD/MMC Card Interface 24

Table 2-8 CSI Interface 25

Table 2-9 Camera Interface 27

Table 2-10 JTAG Interface 28

Table 2-11 Mini USB Interface 29

Table 2-12 Serial Port 30

Table 2-13 Expansion Port Interface 31

Table 2-14 Mini USB (OpenSDA) Interface 33

Table 2-15 RGMII LAN interface 34

Table 2-16 USB Host Interface 35

Table 2-17 Boot Configuration Select 37

Table 2-18 Reset Switch 38

Table 2-19 LEDs 39

Table 3-1 OS and Drivers 40

Table 3-2 Images Required by Linux 40

Table 3-3 Storage Partitions for Linux *41*

Table 3-4 Images Required by Android *41*

Table 3-5 Storage Partitions for Android *41*

Table 4-1 Boot Switch Configuration – Serial Download *43*

Table 4-2 Boot Switch Configuration - eMMC *46*

Table 4-3 Boot Switch Configuration – SD *46*

Table 5-1 Images and Directories *51*

1 Board Overview

1.1 Product Introduction

The RIoTboard is an evaluation platform featuring the powerful i.MX 6Solo, a multimedia application processor with ARM Cortex-A9 core at 1 GHz from Freescale Semiconductor. The platform helps evaluate the rich set of peripherals and includes a 10/100/Gb Ethernet port, HDMI v1.4, LVDS, analog headphone/microphone, uSD and SD card interface, USB, serial port, JTAG, 2 camera interfaces, GPIO boot configuration interface, and expansion port, as shown in Figure 1-1.

The RIoTboard can be used in the following applications:

- Netbooks (web tablets)
- Nettops (Internet desktop devices)
- High-end mobile Internet devices (MID)
- High-end PDAs
- High-end portable media players (PMP) with HD video capability
- Portable navigation devices (PNDs)
- Industrial control and Test and measurement (T&M)
- Single board computers (SBCs)

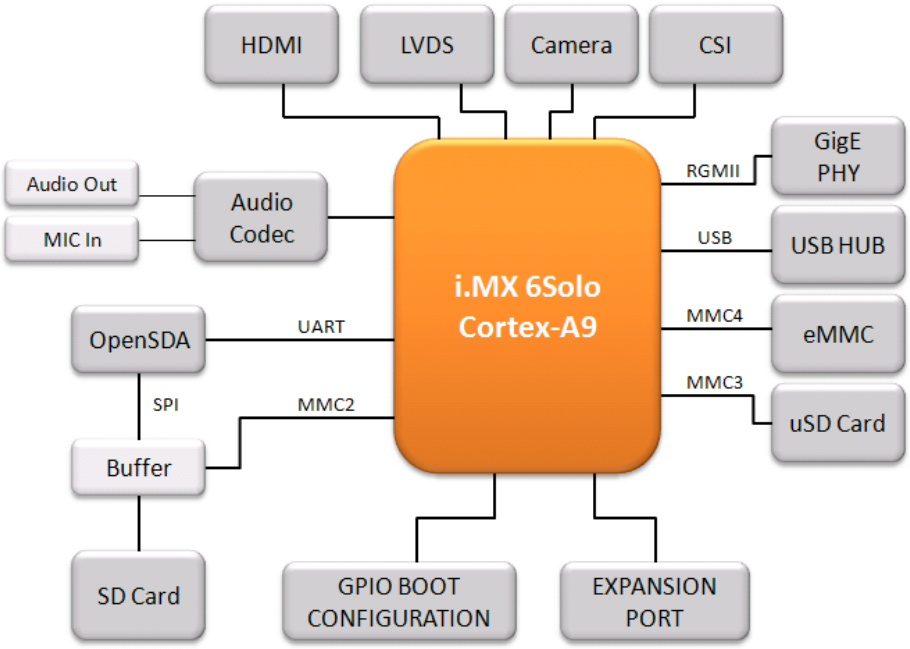


Figure 1-1 Functional Block Diagram

1.2 Features

The RIoTboard is based on the i.MX 6Solo processor from Freescale Semiconductor integrating all the functionalities of this multimedia application processor with the following features:

- Mechanical Parameters
  - Working Temperature: 0°C - 50°C
  - Humidity Range: 20% - 90%
  - Dimensions: 120mm x 75mm
  - Input Voltage: +5V
- Processor
  - ARM Cortex A9 MPCore™ Processor at 1 GHz
  - High-performing video processing unit which covers SD-level and HD-level video decoders and SD-level encoders as a multi-standard video codec engine
  - An OpenGL® ES 2.0 3D graphics accelerator with a shader and a 2D graphics accelerator for superior 3D, 2D, and user interface acceleration
- Memories
  - 1GByte of 16-bit wide DDR3 @ 800MHz
  - 4GB eMMC

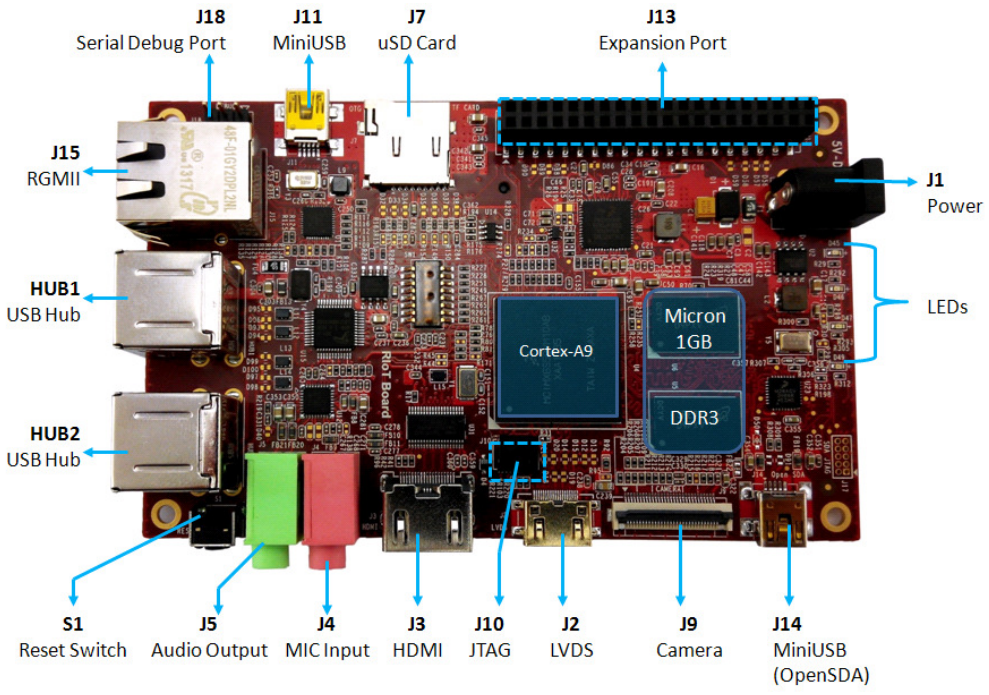


Figure 1-2 RIoTboard top view

- Media Interfaces
  - Analog headphone/microphone, 3.5mm audio jack
  - LVDS interface
  - HDMI interface
  - Parallel RGB interface(Expansion port)
  - Camera interface (Support CCD or CMOS camera)
  - MIPI lanes at 1 Gbps

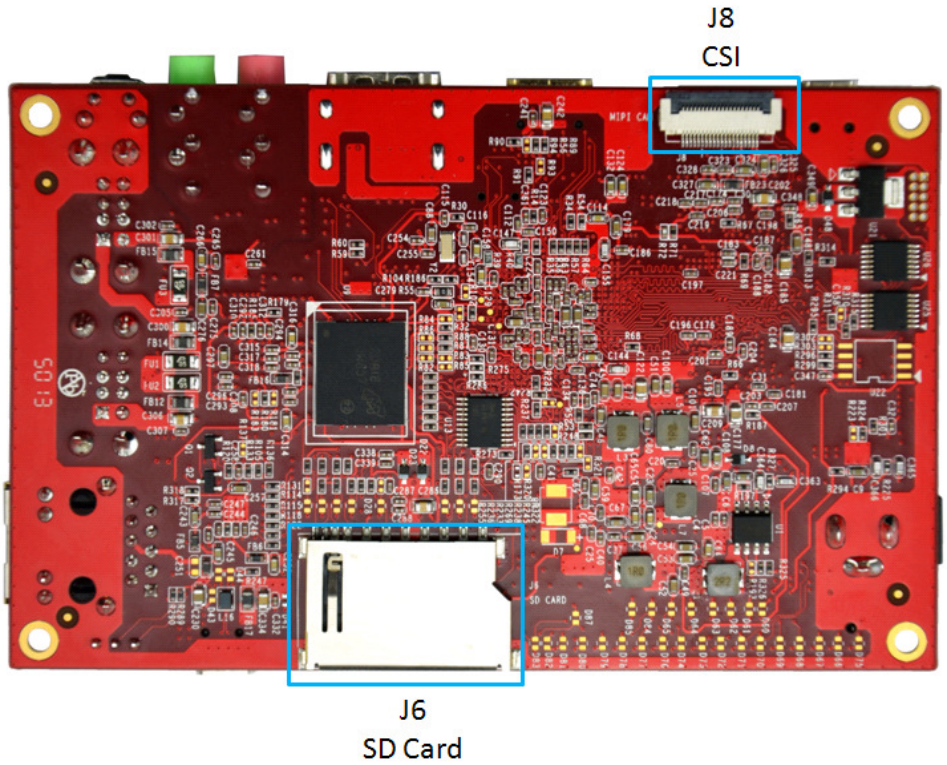


Figure 1-3 RIoTboard bottom view

- Data Transfer Interfaces
  - Debug Ports:
    - 3 pin TTL level
  - Serial Ports:
    - UART3,4,5, 3 line serial port, TTL Logic (Expansion port)
  - USB Ports:
    - 1 x USB2.0 OTG, mini USB, high-speed, 480Mbps
    - 4 x USB2.0 HOST, Type A, high-speed, 480Mbps
  - uSD card interface
  - SD card interface
  - 10M/100M/Gb Ethernet Interface (RJ45 jack)

- 2 channel I2C interface (Expansion port)
- 2 channel SPI interface (Expansion port)
- 3 channel PWM interface (Expansion port)
- GPIO (Expansion port)
- 10-pin JTAG interface
- Open SDA

- Others
  - 1 Power LED
  - 1 Open SDA LED
  - 2 User-defined LEDs
  - 1 DC Jack
  - 1 Reset button
  - Boot configuration interface

2 Hardware Description

2.1 Processor

The i.MX 6Solo processor represents Freescale Semiconductor's latest achievement in integrated multimedia applications processors, which are part of a growing family of multimedia-focused products that offer high performance processing and are optimized for lowest power consumption.

The processor features Freescale's advanced implementation of the single ARM™ Cortex-A9 core, which operates at speeds up to 1 GHz. It includes 2D and 3D graphics processors, 3D 1080p video processing, and integrated power management. The processor provides a 16/32-bit DDR3/LVDDR3-800 memory interface and a number of other interfaces for connecting peripherals, such as WLAN, Bluetooth™, GPS, hard drive, displays, and camera sensors.

2.1.1 Core Features

The i.MX 6Solo processor is based on the ARM Cortex A9 MPCore™ platform with the following features:

- ARM Cortex A9 MPCore™ CPU Processor (with TrustZone)
- The core configuration is symmetric, where the core includes:
  - 32 KByte L1 Instruction Cache
  - 32 KByte L1 Data Cache
  - Private Timer and Watchdog
  - Cortex-A9 NEON MPE (Media Processing Engine) Co-processor
- The ARM Cortex A9 MPCore™ complex includes:
  - General Interrupt Controller (GIC) with 128 interrupt support
  - Global Timer
  - Snoop Control Unit (SCU)
  - 512 KB unified I/D L2 cache
  - Two Master AXI (64-bit) bus interfaces output of L2 cache
  - NEON MPE coprocessor
    - SIMD Media Processing Architecture
    - NEON register file with 32x64-bit general-purpose registers
    - NEON Integer execute pipeline (ALU, Shift, MAC)
    - NEON dual, single-precision floating point execute pipeline (FADD, FMUL)
    - NEON load/store and permute pipeline
- The memory system consists of the following components:
  - Level 1 Cache--32 KB Instruction, 32 KB Data cache per core

- Level 2 Cache--Unified instruction and data (512 KByte)
- On-Chip Memory:
  - Boot ROM, including HAB (96 KB)
  - Internal multimedia / shared, fast access RAM (OCRAM, 128 KB)
  - Secure/non-secure RAM (16 KB)

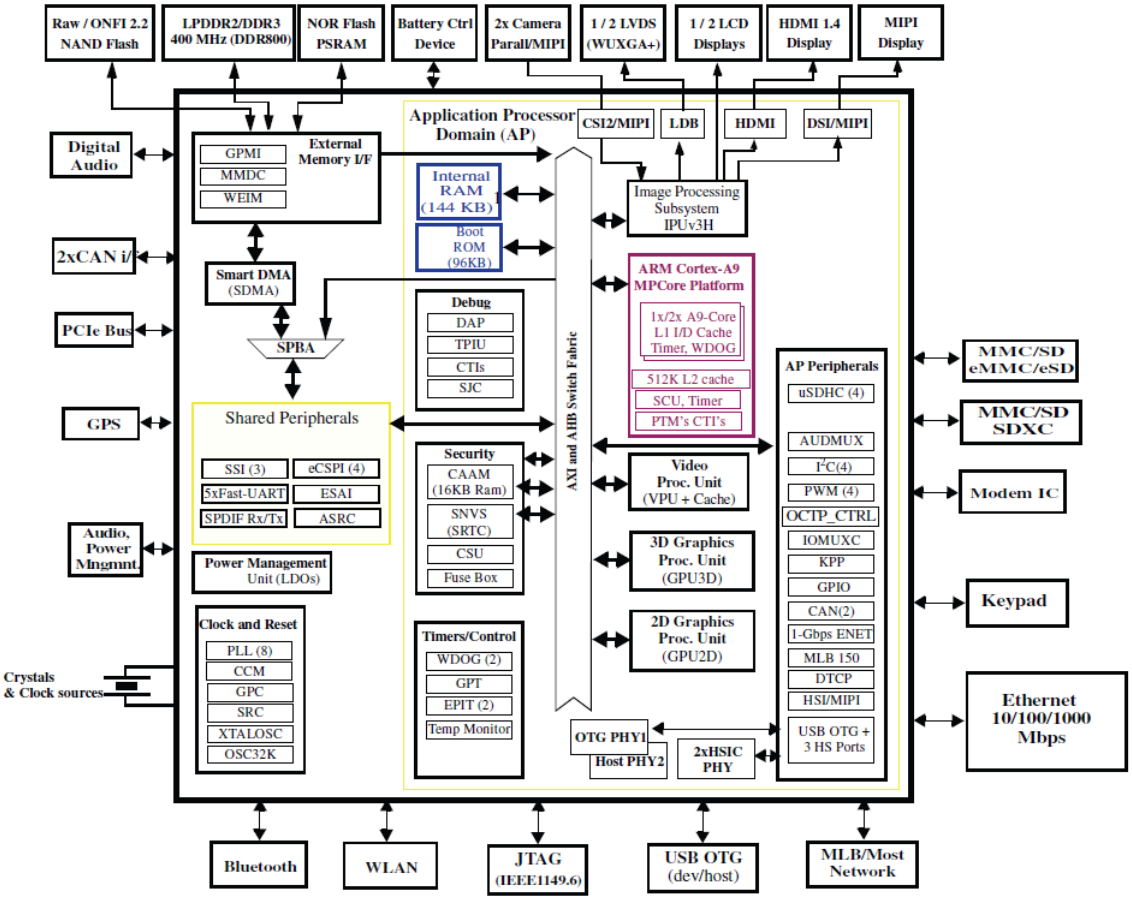


Figure 2-1 Block Diagram of i.MX 6Solo

2.1.2 External memory interfaces:

- 16/32-bit LP-DDR2-800, 16/32-bit DDR3-800 and LV-DDR3-800.
- 8-bit NAND-Flash, including support for Raw MLC/SLC, 2 KB, 4 KB, and 8 KB page size, BA-NAND, PBA-NAND, LBA-NAND, OneNAND™ and others. BCH ECC up to 40 bit.
- 16/32-bit NOR Flash. All WEIMv2 pin are muxed on other interfaces.
- 16/32-bit PSRAM, Cellular RAM

2.1.3 Interface to external devices

Each i.MX 6Solo processor enables the following interfaces to external devices (some of them are muxed and not available simultaneously):

- Displays--Total five interfaces available. Total raw pixel rate of all interfaces is up to 450 Mpixels/sec, 24 bpp. Up to two interfaces may be active in parallel.
  - One Parallel 24-bit display port, up to 225 Mpixes/sec (for example, WUXGA at 60 Hz or dual HD1080 and WXGA at 60 Hz)
  - LVDS serial ports : One port up to 165 Mpixels/sec or two ports up to 85 MP/sec (for example, WUXGA at 60 Hz) each
  - HDMI 1.4 port
  - MIPI/DSI, two lanes at 1 Gbps
  - EPDC, Color, and monochrome E-INK, up to 1650x2332 resolution and 5-bit grayscale
- Camera sensors:
  - Two parallel Camera ports (up to 20 bit and up to 240 MHz peak)
  - MIPI CSI-2 serial camera port, supporting from 80 Mbps to 1 Gbps speed per data lane. The CSI-2 Receiver core can manage one clock lane and up to two data lanes. Each i.MX 6Solo processor has two lanes.
- Expansion cards:
  - Four MMC/SD/SDIO card ports all supporting:
    - 1-bit or 4-bit transfer mode specifications for SD and SDIO cards up to UHS-I SDR-104 mode (104 MB/s max)
    - 1-bit, 4-bit, or 8-bit transfer mode specifications for MMC cards up to 52 MHz in both SDR and DDR modes (104 MB/s max)
- USB
  - One high speed (HS) USB 2.0 OTG (Up to 480 Mbps), with integrated HS USB PHY
  - Three USB 2.0 (480 Mbps) hosts
    - One HS host with integrated High Speed PHY
    - Two HS hosts with integrated HS-IC USB (High Speed Inter-Chip USB) PHY
- Expansion PCI Express port (PCIe) v2.0 one lane
  - PCI Express (Gen 2.0) dual mode complex, supporting Root complex operations and Endpoint operations. Uses x1 PHY configuration.
- Miscellaneous IPs and interfaces:
  - Three I2S/SSI/AC97,up to 1.4 Mbps each
  - Enhanced Serial Audio Interface ESAI), up to 1.4 Mbps per channel
  - Five UARTs, up to 4.0 Mbps each
    - Providing RS232 interface
    - Supporting 9-bit RS485 multidrop mode

        - One of the five UARTs (UART1) supports 8-wire while the other four support 4-wire. This is due to the SoC IOMUX limitation, since all UART IPs are identical
    - Four eCSPI (Enhanced CSI)
    - Four I2C, supporting 400 kbps
    - Gigabit Ethernet Controller(IEEE1588 compliant), 10/100/1000 Mbps
    - Four Pulse Width Modulators (PWM)
    - System JTAG Controller (SJC)
    - GPIO with interrupt capabilities
    - 8x8 Key Pad Port (KPP)
    - Sony Philips Digital Interface (SPDIF), Rx and Tx
    - Two Controller Area Network (FlexCAN), 1 Mbps each
    - Two Watchdog timers (WDOG)
    - Audio MUX (AUDMUX)
    - MLB (MediaLB) provides interface to MOST Networks (MOST25, MOST50, MOST150) with the option of DTCP cipher accelerator

2.1.4 Advanced Power Management unit

The i.MX 6Solo processors integrate advanced power management unit and controllers:

- Provide PMU, including LDO supplies, for on-chip resources
- Use Temperature Sensor for monitoring the die temperature
- Support DVFS techniques for low power modes
- Use SW State Retention and Power Gating for ARM and MPE
- Support various levels of system power modes
- Use flexible clock gating control scheme

2.1.5 Hardware Accelerators

The i.MX 6Solo processor uses dedicated hardware accelerators to meet the targeted multimedia performance. The use of hardware accelerators is a key factor in obtaining high performance at low power consumption numbers, while having the CPU core relatively free for performing other tasks.

The i.MX 6Solo processor incorporates the following hardware accelerators:

- VPU--Video Processing Unit
- IPUv3H--Image Processing Unit version 3H
- GPU3Dv5--3D Graphics Processing Unit (OpenGL ES 2.0) version 5
- GPU2Dv2--2D Graphics Processing Unit (BitBlt)
- ASRC--Asynchronous Sample Rate Converter

Security functions are enabled and accelerated by the following hardware:

- ARM TrustZone including the TZ architecture (separation of interrupts, memory mapping, etc.)
- SJC--System JTAG Controller. Protecting JTAG from debug port attacks by regulating or blocking the access to the system debug features.
- CAAM--Cryptographic Acceleration and Assurance Module, containing cryptographic and hash engines, 16 KB secure RAM and True and Pseudo Random Number Generator (NIST certified)
- SNVS--Secure Non-Volatile Storage, including Secure Real Time Clock
- CSU--Central Security Unit. Enhancement for the IC Identification Module (IIM). Will be configured during boot and by eFUSEs and will determine the security level operation mode as well as the TZ policy.
- A-HAB Advanced High Assurance Boot--Hv4 with the new embedded enhancements:SHA-256, 2048-bit RSA key, version control mechanism, warm boot, CSU, and TZ initialization.

2.2 Expanded Chip Introduction

2.2.1 MT41K256M16HA-125:E

The board has 1GB of SDRAM (2x512MB). Micron's MT41K256M16 is a 512MB DDR3 Synchronous DRAM, ideally suited for the main memory applications which require large memory density and high bandwidth.

2.2.2 MMPF0100NPAEP

The PF0100 Power Management Integrated Circuit (PMIC) provides a highly programmable/ configurable architecture, with fully integrated power devices and minimal external components. With up to six buck converters, six linear regulators, RTC supply, and coin-cell charger, the PF0100 can provide power for a complete system, including applications processors, memory, and system peripherals, in a wide range of applications. With on-chip One Time Programmable (OTP) memory, the PF0100 is available in pre-programmed standard versions, or non-programmed to support custom programming. The PF0100 is defined to power the entire embedded MCU platform solution similar to i.MX6 based eReader, IPTV, medical monitoring and home/factory automation.

2.2.3 AR8035

AR8035 is a single port 10/100/1000 Mbps tri-speed Ethernet PHY feaured with low power and low cost. AR8035 supports MAC.TM RGMII interface and IEEE 802.3az-2010, Energy Efficient Ethernet (EEE) standard through proprietary SmartEEE technology, improving energy efficiency in systems using legacy MAC devices without 802.3az

support. The RIOT Board can be connected to a network hub directly through a cable. It also can be directly connected with a computer through a crossover cable which is provided with the kit.

2.2.4 FE1.1

FE1.1 is a USB 2.0 high-speed 4-port hub solution. It uses USB3320 to provide 4 extended USB interface with support for high-speed (480MHz), full-speed (2MHz) and low-speed (1.5MHz) mode.

2.2.5 SGTL5000

The SGTL5000 is a low power stereo Codec with Headphone Amp from Freescale, and is designed to provide a complete audio solution for portable products needing line-in, mic-in, line-out, headphone-out, and digital I/O. Deriving its architecture from best-in-class Freescale-integrated products currently on the market, the SGTL5000 is able to achieve ultra low-power with very high performance and functionality, all in one of the smallest footprints available.

Designed with features such as capless headphone and an integrated PLL to allow clock reuse within the system, it helps customers achieve a lower overall system cost.

2.3 Expanded Chip Introduction

2.3.1 Power Input Jack

A 5V/1A AC-to-DC power supply needs to be plugged into the Power Jack (J1) on the board. *It is not recommended to use a higher voltage since possible damage to the board may result due to failure of the protection circuitry.*

Figure 2-2 Power Interface

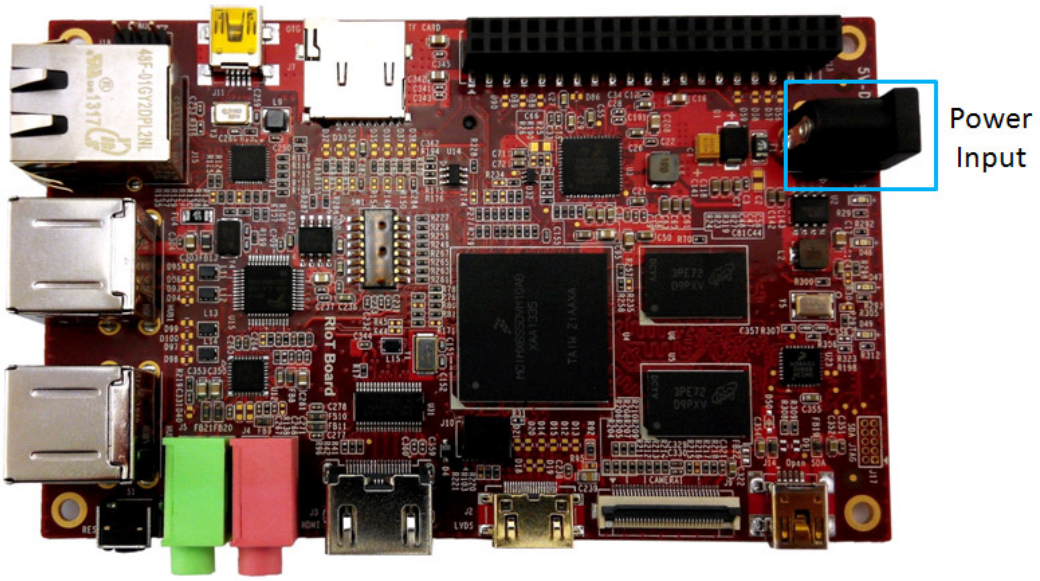
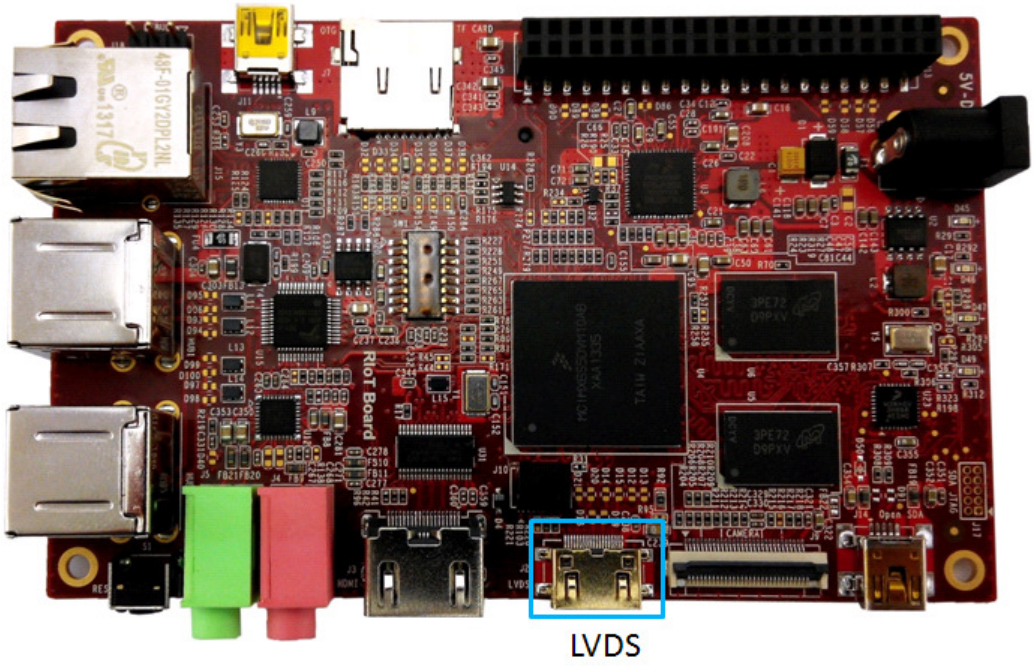


Table 2-1 Power Interface

J1		
Pin	Signal	Function
1	GND	GND
2	NC	NC
3	+5V	Power supply (+5V) 1A (Type)

2.3.2 LVDS Interface

Figure 2-3 LVDS Interface



The LVDS Interface supports LVDS8000-97C designed by Embest.

Table 2-2 LVDS Interface

J2		
Pin	Signal	Function
1	3V3	+3.3V
2	LVDS_TX2_P	LVDS data2+
3	LVDS_TX2_N	LVDS data2-
4	GND	GND
5	LVDS_TX1_P	LVDS data1+
6	LVDS_TX1_N	LVDS data1-
7	GND	GND
8	LVDS_TX0_P	LVDS data0+
9	LVDS_TX0_N	LVDS data-
10	GND	GND
11	LVDS_CLK_P	LVDS CLK+
12	LVDS_CLK_N	LVDS CLK-

13	LCD_PWR_EN	Touch reset signal
14	Touch_Int	Touch interrupt signal
15	I2C_SCL	IIC master serial clock
16	I2C_SDA	IIC master serial data
17	LED_PWR_EN	Backlight enable
18	5V	+5V
19	PWM	Pulse Width Modulation

2.3.3 HDMI Interface

Figure 2-4 HDMI Interface

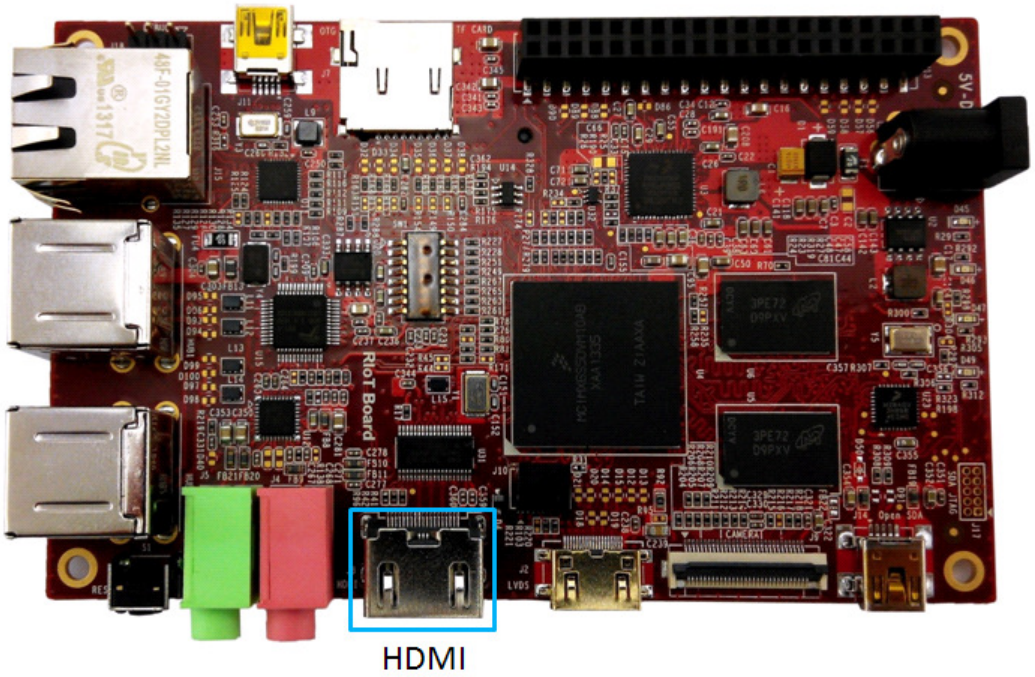


Table 2-3 HDMI Interface

J3		
Pin	Signal	Function
1	HDMI_D2P	HDMI differential pairs data2+
2	GND	GND
3	HDMI_D2M	HDMI differential pairs data2-
4	HDMI_D1P	HDMI differential pairs data1+
5	GND	GND

6	HDMI_D1M	HDMI differential pairs data1-
7	HDMI_D0P	HDMI differential pairs data0+
8	GND	GND
9	HDMI_D0M	HDMI differential pairs data0-
10	HDMI_CLKP	HDMI differential pairs clock+
11	GND	GND
12	HDMI_CLKM	HDMI differential pairs clock-
13	NC	NC
14	NC	NC
15	BI2C2_SCL	IIC2 serial clock
16	BI2C2_SDA	IIC2 serial data
17	GND	GND
18	5Vin	5V
19	HDMI_HPD	HDMI detect
20	GNF_DVI	GND

2.3.4 Microphone Input Jack

The RIoTboard provides a 3.5mm stereo connector for a microphone input, as shown in Figure 2-5. A mono microphone will input its signal though the tip of the 3.5mm plug.

Figure 2-5 MIC Input

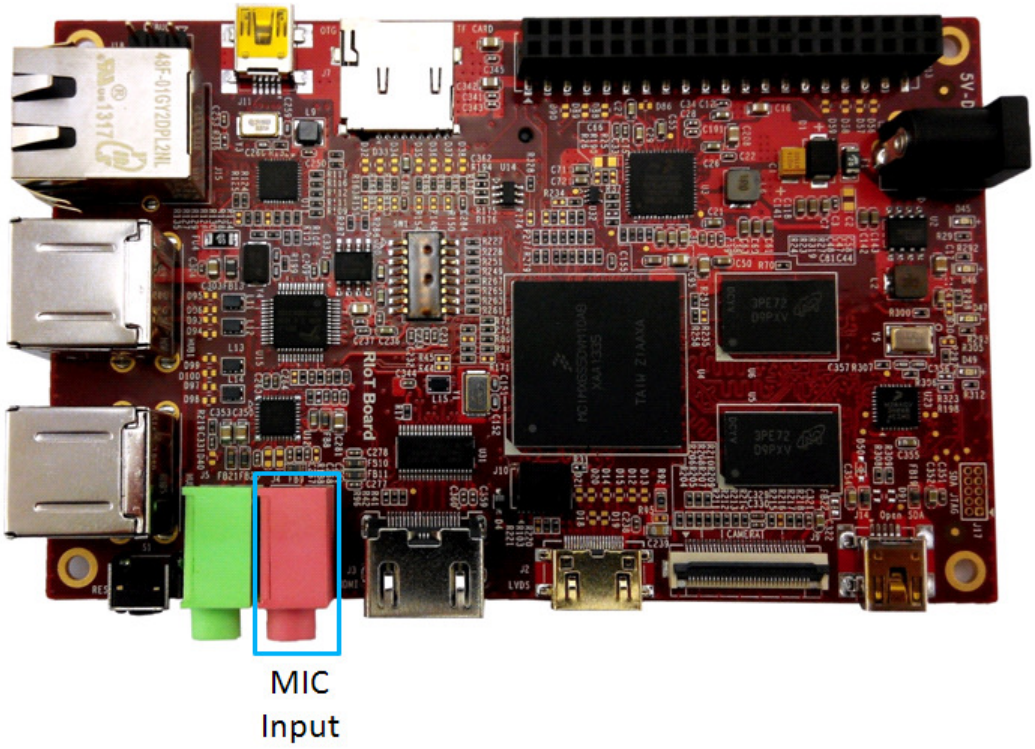


Table 2-4 MIC Input Jack

J4		
Pin	Signal	Function
1	GND_ANALOG	Analog GND
2	MIC_IN_P	MIC input analog GND
3	GND_ANALOG	Analog GND
4	GND_ANALOG	Analog GND
5	MIC_IN_P	MIC input analog GND

2.3.5 Audio Output Jack

A headphone with a standard 3.5mm stereo jack can be connected to the Audio Output jack at the point shown in Figure 2-6.

Figure 2-6 Audio Output Jack

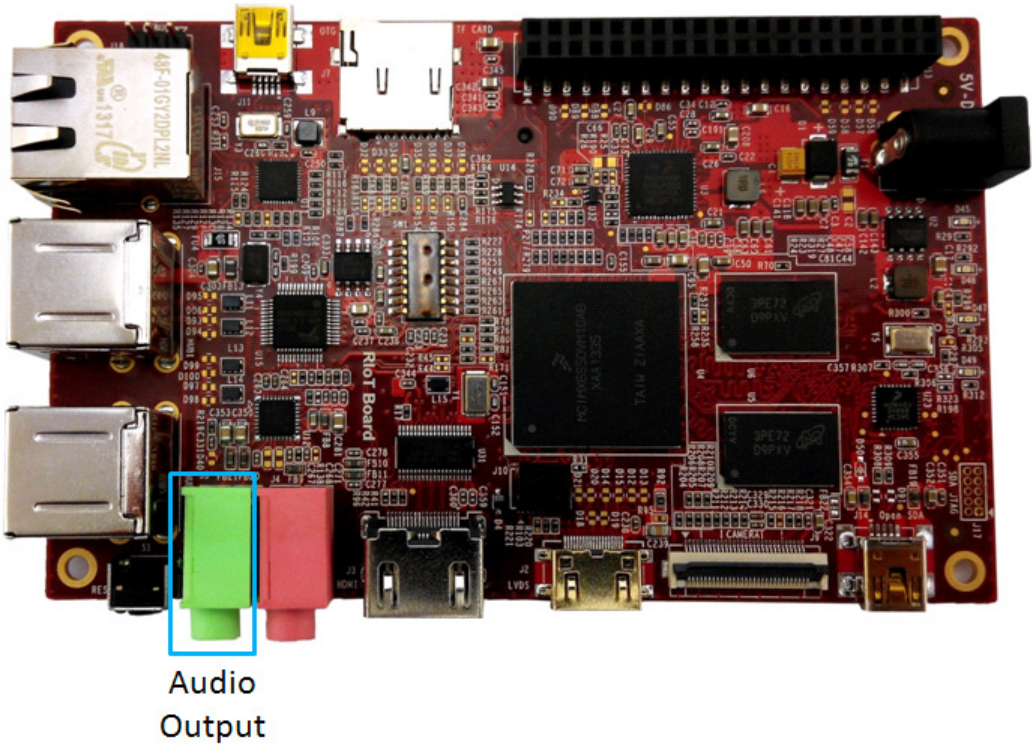


Table 2-5 Audio Output Jack

J5		
Pin	Signal	Function
1	GND_ANALOG	Analog GND
2	LINEOUT_L	Left output
3	LINEOUT_R	Right output
4	LINEOUT_R	Right output
5	LINEOUT_L	Left output

2.3.6 SD Card Interface

Figure 2-7 SD Card Interface

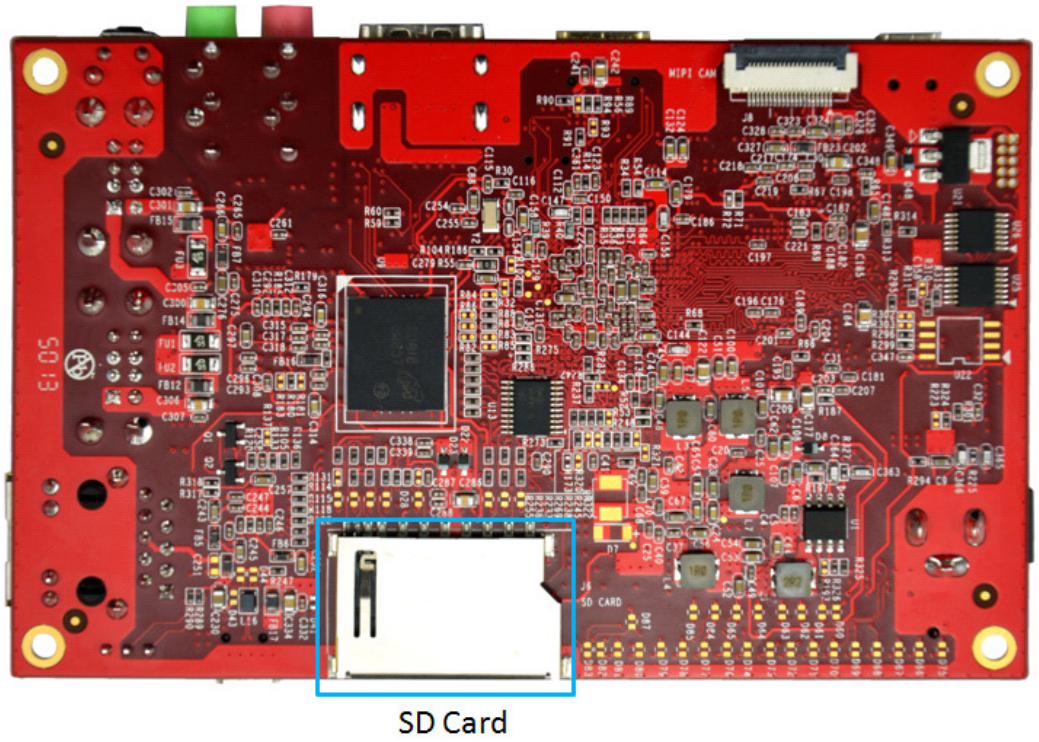


Table 2-6 SD Card Interface

J6		
Pin	Signal	Function
1	SD2_DAT3	Card data 3
2	SD2_CMD	Command signal
3	GND	GND
4	3P3V	3.3V
5	SD2_CLK	Clock
6	VSS	GND
7	SD2_DAT0	Card data 0
8	SD2_DAT1	Card data 1
9	SD2_DAT2	Card data 2

10	SD2_CD	Card detect
11	SD2_WP	Card write protected
12	GND	GND
13	GND	GND
14	GND	GND
15	GND	GND

2.3.7 uSD/MMC Card Interface

The micro SD Card Connector (J7) connects a 4-bit parallel data bus to the SD3 port of the i.MX 6 processor. The micro SD Card is inserted facing up at the location shown in Figure 2-8.

Figure 2-8 uSD/MMC Card Interface

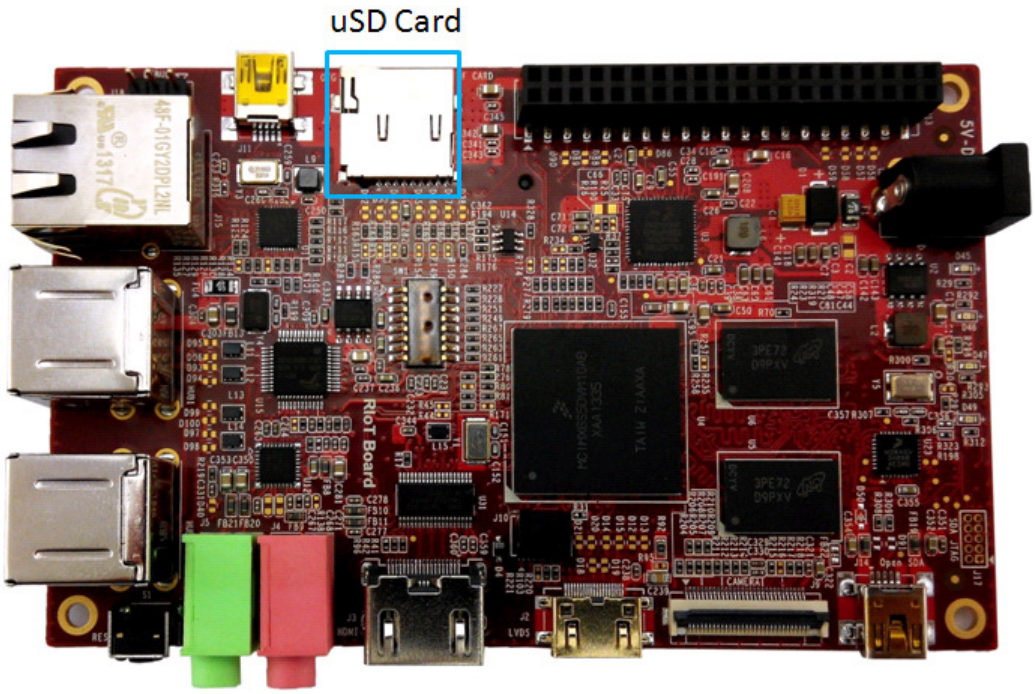


Table 2-7 uSD/MMC Card Interface

J7		
Pin	Signal	Function
1	SD3_DAT2	Card data 2
2	SD3_DAT3	Card data 3
3	CMD	Card command signal

4	3P3V	3P3V
5	SD3_CLK	Card clock
6	VSS	GND
7	SD3_DAT0	Card data 0
8	SD3_DAT1	Card data 1
9	SD3_CD	Card detect
10	PGND	GND

2.3.8 CSI Interface

Figure 2-9 CSI Interface

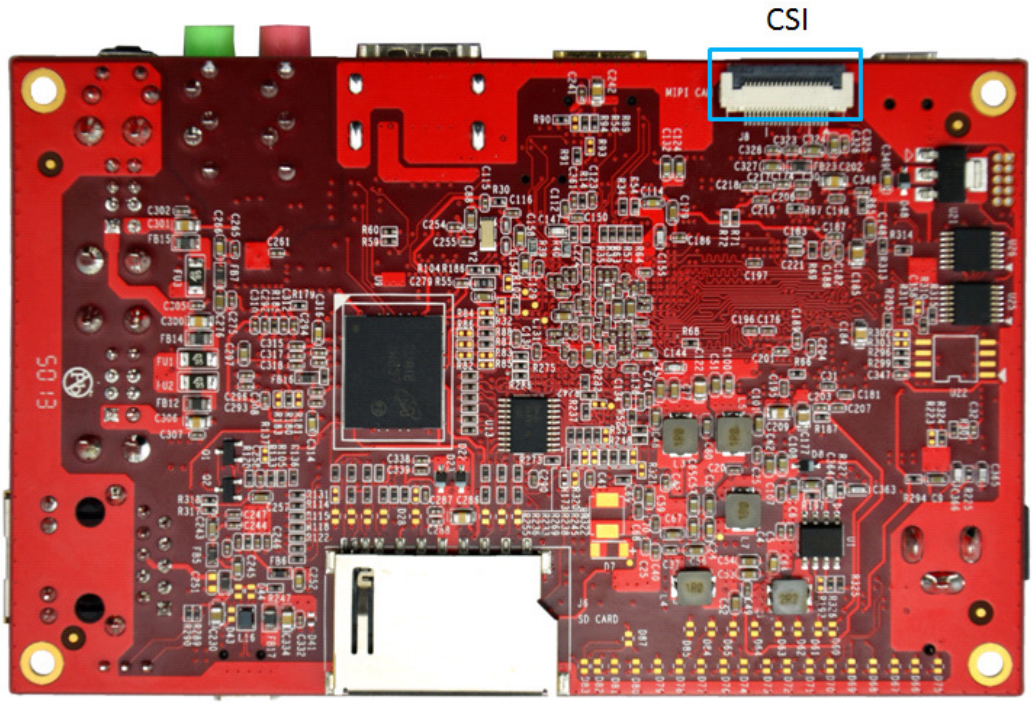


Table 2-8 CSI Interface

J8		
Pin	Signal	Function
1	5VIN	5V
2	5VIN	5V
3	GND	GND
4	GND	GND

5	P2V8_VGEN6	2.8V
6	CSI_MCLK	CSI clock
7	GND	GND
8	CSI_RST	CSI reset
9	CSI_EN	CSI data enable
10	I2C4_SCL	IIC2 serial clock
11	I2C4_SDA	IIC2 serial data
12	GND	GND
13	CSI_CLK0M	CSI differential pairs clock0-
14	CSI_CLK0P	CSI differential pairs clock0+
15	GND	GND
16	CSI_D0M	CSI differential pairs data0-
17	CSI_D0P	CSI differential pairs data0+
18	GND	GND
19	CSI_D1M	CSI differential pairs data1-
20	CSI_D1P	CSI differential pairs data1+

2.3.9 Camera Interface

Figure 2-10 Camera Interface

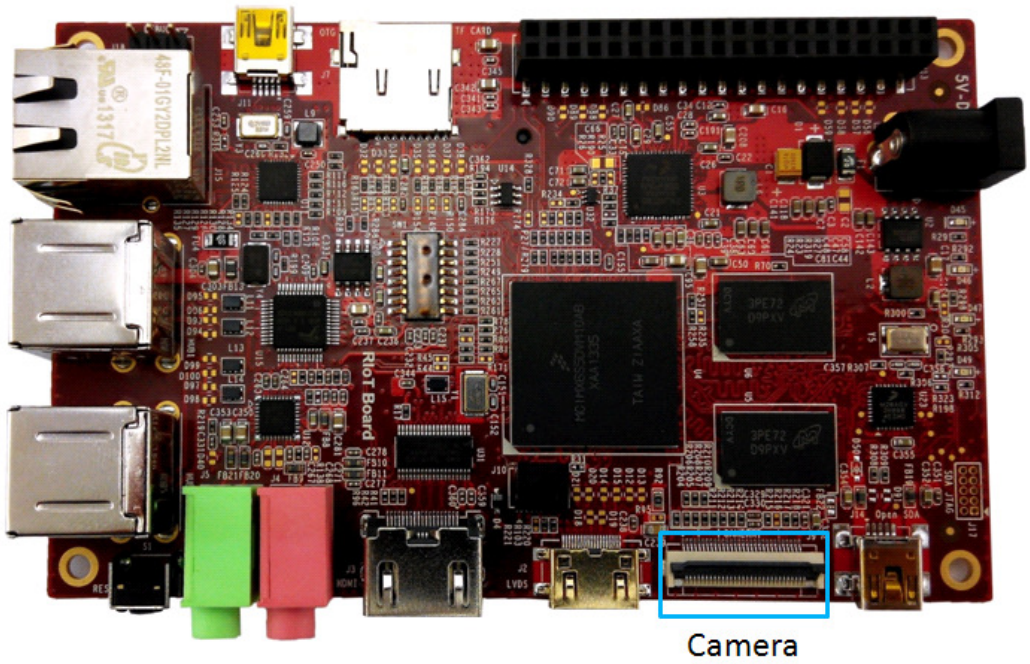


Table 2-9 Camera Interface

J9		
Pin	Signal	Function
1	GND	GND
2	NC	NC
3	NC	NC
4	CSI0_DAT12	CSI0 capture data bit 12
5	CSI0_DAT13	CSI0 capture data bit 13
6	CSI0_DAT14	CSI0 capture data bit 14
7	CSI0_DAT15	CSI0 capture data bit 15
8	CSI0_DAT16	CSI0 capture data bit 16
9	CSI0_DAT17	CSI0 capture data bit 17
10	CSI0_DAT18	CSI0 capture data bit 18
11	CSI0_DAT19	CSI0 capture data bit 19
12	NC	NC
13	NC	NC
14	GND	GND
15	CSI0_PIXCLK	CSI0 pixel clock
16	GND	GND
17	CSI0_HSYNC	CSIO HSYNC
18	NC	NC
19	CSI0_VSYNC	CSIO VSYNC
20	VDD_NVCC	3.3V
21	CAM_MCLK	Camera clock
22	NC	NC
23	GND	GND
24	NC	NC
25	CAM_RST	CSI0 reset
26	CAM_EN	CSI0 data enable
27	I2C4_SDA	I2C2 serial data
28	I2C4_SCL	I2C2 serial clock
29	GND	GND
30	P1V8_SW4	1.8V

2.3.10 JTAG Interface

Figure 2-11 JTAG Interface

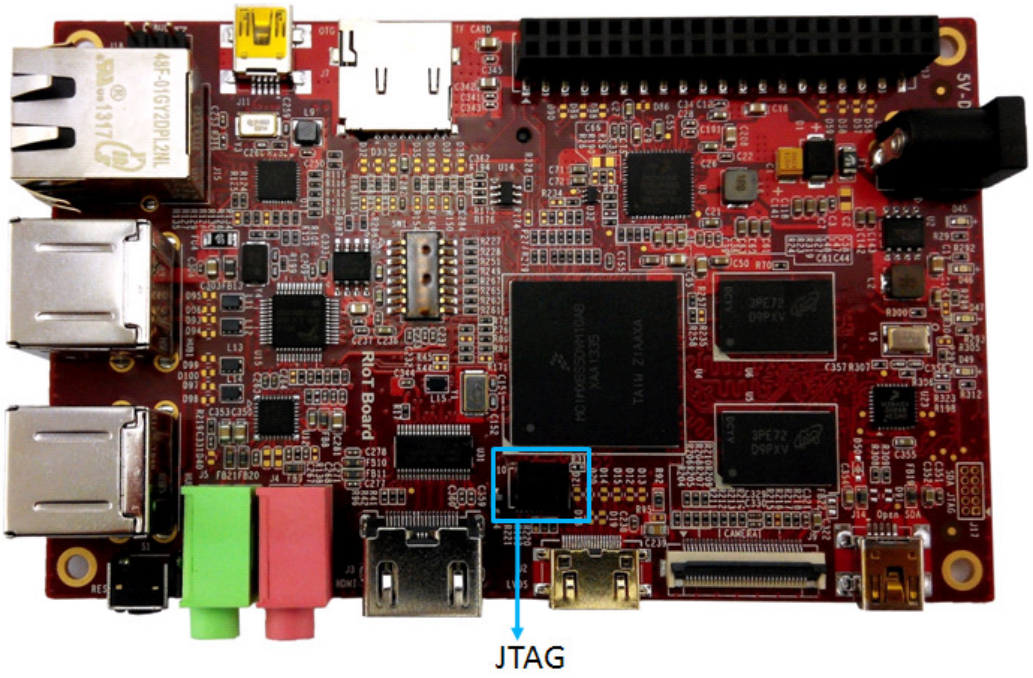


Table 2-10 JTAG Interface

J10		
Pin	Signal	Function
1	VDD_NVCC	3.3V
2	JTAG_TMS	Test mode select
3	GND	GND
4	JTAG_TCK	Test clock
5	GND	GND
6	JTAG_TDO	Test data output
7	JTAG_MOD	Test mode
8	JTAG_TDI	Test data input
9	JTAG_nTRST	Test system reset
10	RESET_N	Reset

2.3.11 Mini USB Interface

The mini USB connector is connected to the high-speed (HS) USB 2.0 OTG module of the i.MX 6Solo processor and is cross connected with the lower USB Host port on J3. When a 5V supply is seen on the mini USB connector (from the USB Host), the i.MX 6Solo processor will configure the OTG module to device mode, which will prevent the lower USB Host port from operating correctly.

Figure 2-12 Mini USB Interface

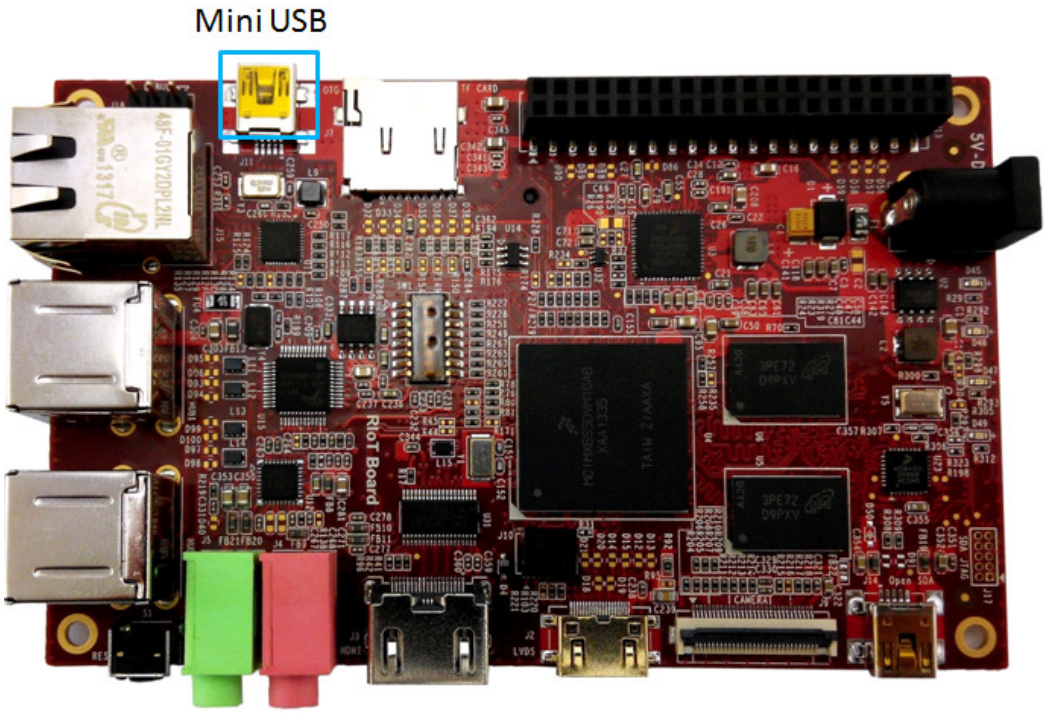


Table 2-11 Mini USB Interface

J11		
Pin	Signal	Function
1	USB_OTG_VBUS	+5V
2	USB_OTG_DN	USB data-
3	USB_OTG_DP	USB data+
4	USB_OTG_ID	USB ID
5	GND	GND

2.3.12 Serial Port

Figure 2-13 Serial Port

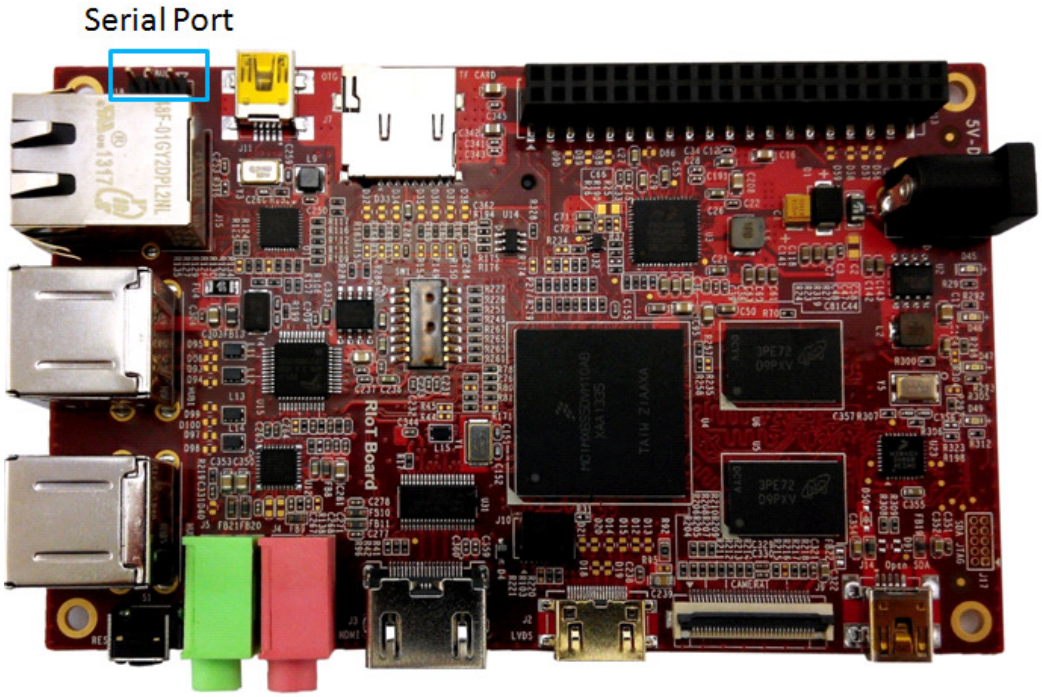


Table 2-12 Serial Port

J18		
Pin	Signal	Function
1	UART2_TXD	UART2 transmit data
2	UART2_RXD	UART2 receive data
3	GND	GND

2.3.13 Expansion Port Interface

Figure 2-14 Expansion Port

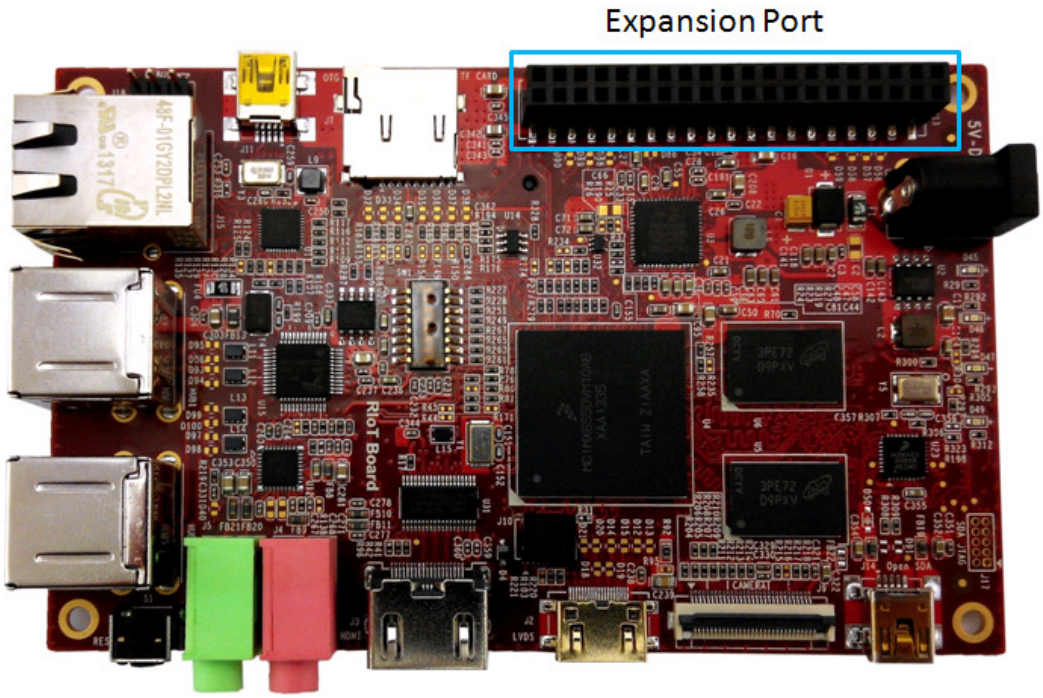


Table 2-13 Expansion Port Interface

J13		
Pin	Signal	Function
1	VDD_NVCC	3.3V
2	5VIN	5V
3	GND	GND
4	GND	GND
5	GPIO4_16	GPIO
6	CSPI3_CLK	SPI3 clock
7	GPIO4_17	GPIO
8	CSPI3_MOSI	SPI3 master output salve input
9	GPIO4_18	GPIO
10	CSPI3_MISO	SPI3 master input salve output
11	GPIO4_19	GPIO
12	CSPI3_CS0	SPI3 chip select 0
13	CSPI3_CS1	SPI3 chip select 1

14	CSPI2_CS1	SPI2 chip select 1
15	GPIO4_31	GPIO
16	CSPI2_MOSI	SPI2 master output salve input
17	GPIO5_05	GPIO
18	CSPI2_MISO	SPI2 master input salve output
19	GPIO5_06	GPIO
20	CSPI2_CS0	SPI2 chip select 0
21	GPIO5_07	GPIO
22	CSPI2_CLK	SPI2 clock
23	GPIO5_08	GPIO
24	UART3_RXD	UART3 receive data
25	GPIO4_26	GPIO
26	UART3_TXD	UART3 transmit data
27	GPIO4_27	GPIO
28	UART4_RXD	UART4 receive data
29	CSPI3_RDY	SPI3 data validation
30	UART4_TXD	UART4 transmit data
31	I2C3_SCL	I2C3 master serial clock
32	UART5_RXD	UART5 receive data
33	I2C3_SDA	I2C3 master serial data
34	UART5_TXD	UART5 transmit data
35	I2C4_SCL	I2C4 master serial clock
36	PWM1	Pulse Width Modulation
37	I2C4_SDA	I2C4 master serial data
38	PWM2	Pulse Width Modulation
39	GND	GND
40	PWM3	Pulse Width Modulation

2.3.14 Mini USB Interface (OpenSDA)

Figure 2-15 Mini USB (OpenSDA)Interface

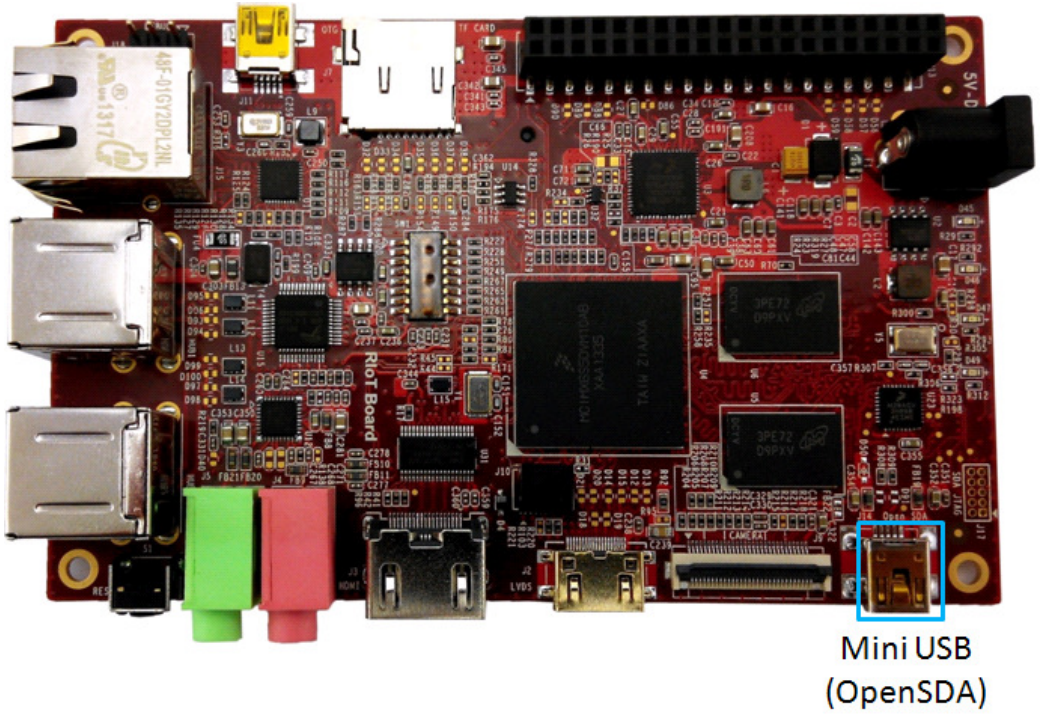


Table 2-14 Mini USB (OpenSDA) Interface

J14		
Pin	Signal	Function
1	V5V_SDA	+5V
2	SDA_USB_DN	SDA USB data-
3	SDA_USB_DP	SDA USB data+
4	NC	NC
5	GND	GND

Note:

The RIoTboard has hardware to support Freescale's OpenSDA interface. Currently this interface has not been enabled in software

2.3.15 RGMII LAN Interface

The Ethernet connector contains integrated magnetic which allows the Ethernet IC to auto configure the port for the correct connection to either a switch or directly to a host PC on a peer-to-peer network. It is not necessary to use a crossover cable when connecting directly to another computer. The Ethernet connector is shown in Figure 2-16.

Figure 2-16 RGMII LAN Interface

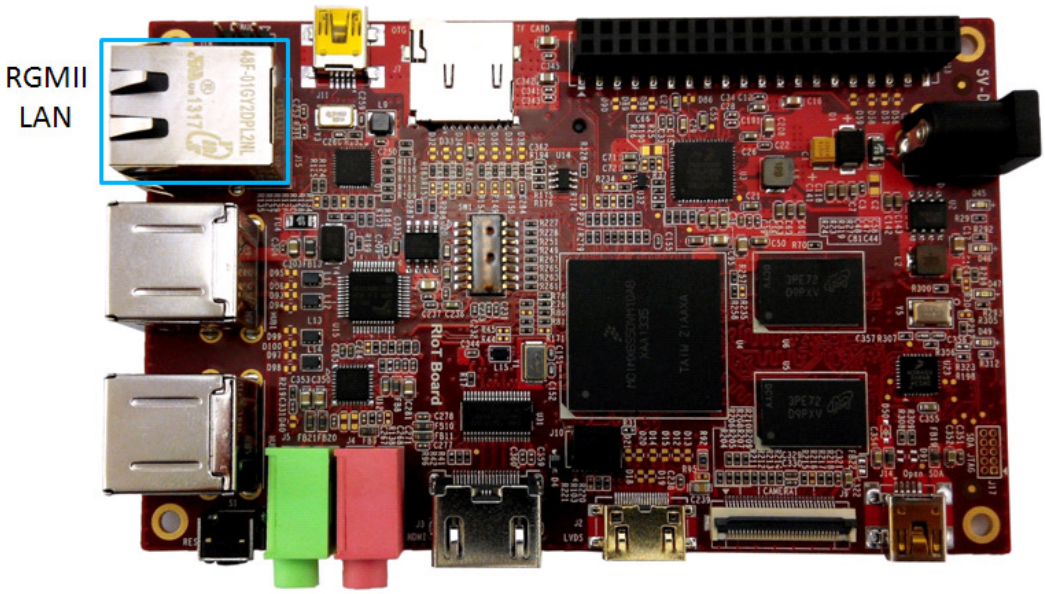


Table 2-15 RGMII LAN interface

J15		
Pin	Signal	Function
1	TD1+	TD1+ output
2	TD1-	TD1- output
3	TD2+	TD2+ output
4	TD2-	TD2- output
5	TCT	2.5V power for TD
6	RCT	2.5V power for RD
7	RD1+	RD1+ input
8	RD1-	RD1- input
9	RD2+	RD2+ input
10	RD2-	RD2- input

11	GRLA	Green LED link signal
12	GRLC	Power supply for green LED
13	YELC	Yellow LED action signal
14	YELA	Power supply for yellow LED

2.3.16 USB HUB Interface

Figure 2-17 USB Host Interface

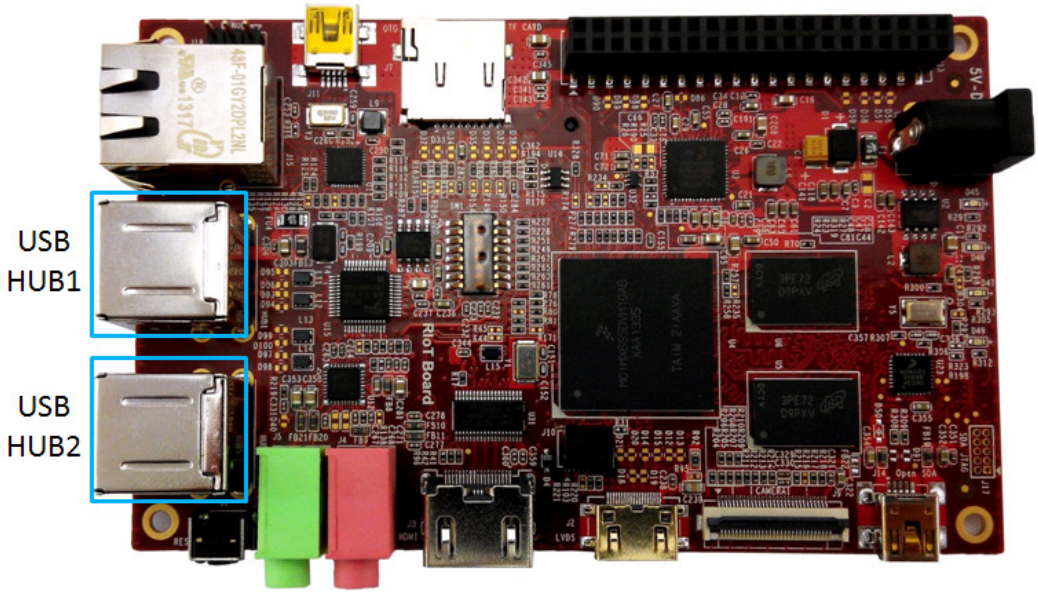


Table 2-16 USB Host Interface

HUB1		
Pin	Signal	Function
1	USB_PWR3	+5V
2	USB_DM3	USB data-
3	USB_DP3	USB data+
4	GND	GND
5	USB_PWR4	+5V
6	USB_DM4	USB data-
7	USB_DP4	USB data+
8	GND	GND

HUB2		
Pin	Signal	Function
1	USB_PWR1	+5V
2	USB_DM1	USB data-
3	USB_DP1	USB data+
4	GND	GND
5	USB_PWR2	+5V
6	USB_DM2	USB data-
7	USB_DP2	USB data+
8	GND	GND

2.3.17 Boot Configuration Select

Figure 2-18 Boot Configuration Select

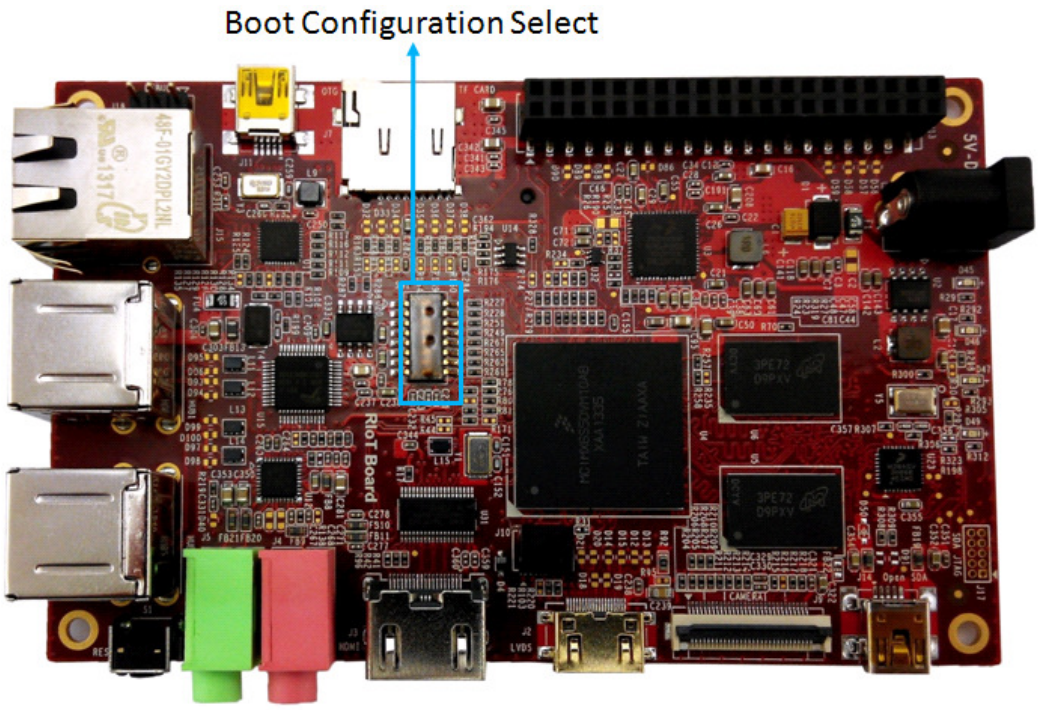


Table 2-17 Boot Configuration Select

SW1		
Pin	Signal	Function
1	P3V0_STBY	P3V0_STBY
2	P3V0_STBY	P3V0_STBY
3	VDD_NVCC	VDD_NVCC
4	VDD_NVCC	VDD_NVCC
5	VDD_NVCC	VDD_NVCC
6	VDD_NVCC	VDD_NVCC
7	VDD_NVCC	VDD_NVCC
8	VDD_NVCC	VDD_NVCC
9	EIM_DA11	BT_CFG2_3
10	EIM_DA12	BT_CFG2_4
11	EIM_DA13	BT_CFG2_5
12	EIM_DA14	BT_CFG2_6
13	EIM_DA5	BT_CFG1_5
14	EIM_DA6	BT_CFG1_6
15	BOOT_MODE0	BOOT_MODE0
16	BOOT_MODE1	BOOT_MODE1

2.3.18 Reset Switch

Figure 2-19 Reset Switch

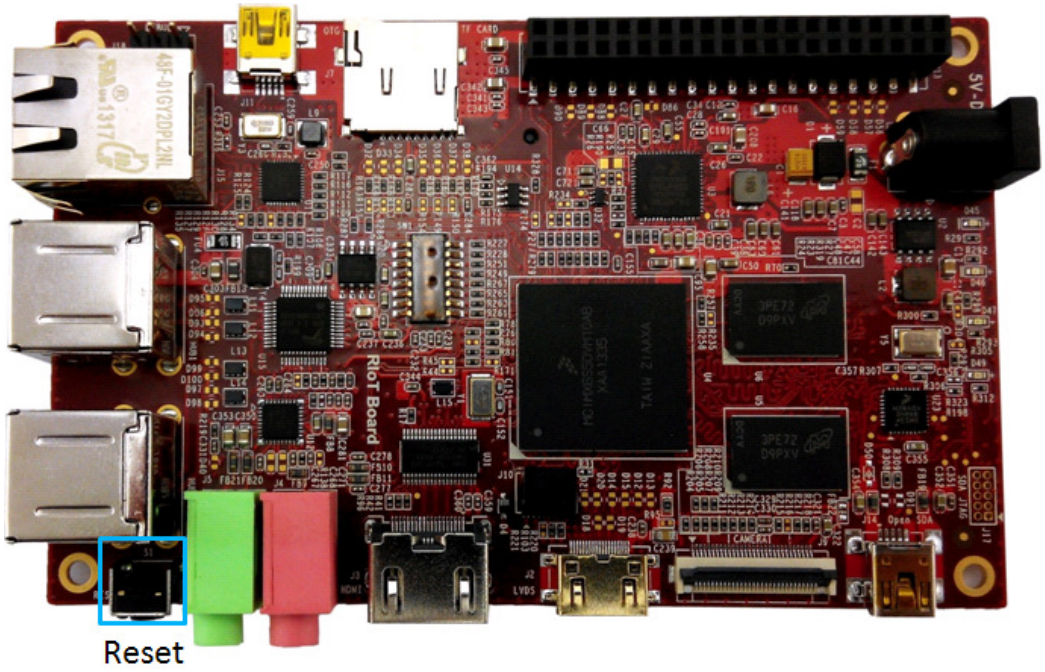


Table 2-18 Reset Switch

S1		
Pin	Signal	Function
1	GND	GND
2	POR_B	System reset
3	NC	NC
4	NC	NC

2.3.19 LEDs

Figure 2-20 LEDs

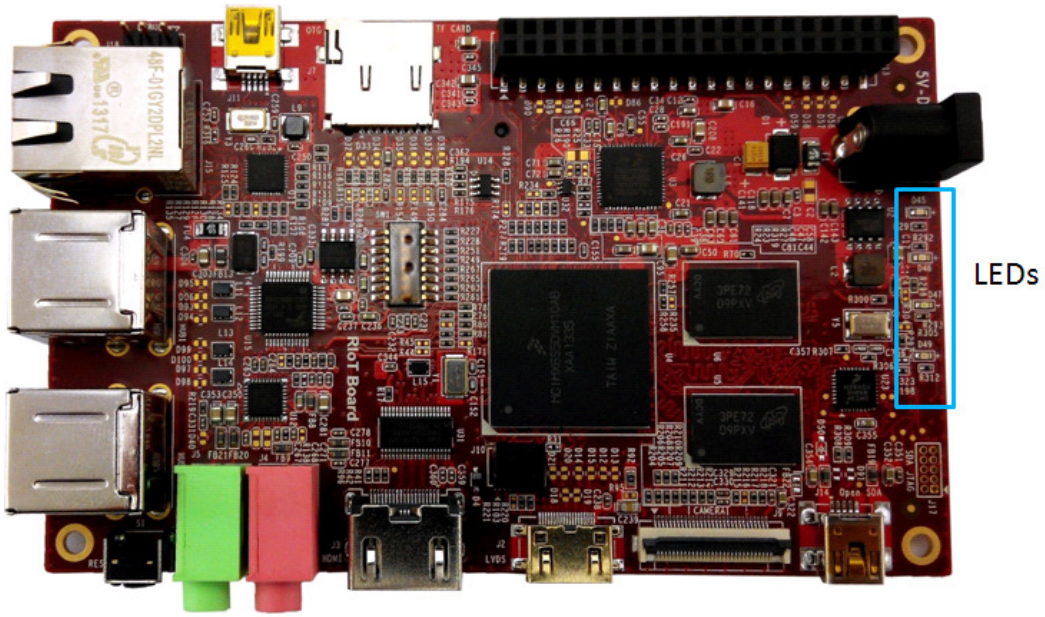


Table 2-19 LEDs

LED	
Reference	Function
D45	User-defined LED
D46	User-defined LED
D47	Power LED
D49	OpenSDA LED

3 Getting Started

Before you start to use RIoTboard, please read the following sections to get yourself familiar with the system images, driver code and tools which might be involved during development process.

NOTE: All images and tools for Android and Linux can be downloaded from www.element14.com/riotboard

3.1 Software Features

The table shown below lists the versions of Linux and Android systems, as well as the device drivers.

Table 3-1 OS and Drivers

Types		Notes
OS	Linux	Version 3.0.35
	Ubuntu	Version 11.10
	Android	Version 4.3
Device Drivers	Serial	Series driver
	RTC	Hardware clock driver
	Net	10/100/Gb IEEE1588 Ethernet
	Display	Two display ports (LVDS, and HDMI 1.4a)
	MMC/SD	Two SD 3.0/SDXC card slot & eMMC
	USB	5 High speed USB ports (4xHost, 1xOTG)
	Audio	Analog (headphone & mic) and Digital (HDMI)
	Camera	Two camera ports (1xParallel, 1x MIPI CSI-2)
	LED	User leds driver

3.2 Linux System

The following tables list the specific images and eMMC storage patitions required to build a Linux system.

Table 3-2 Images Required by Linux

Images	Paths
u-boot image	u-boot-mx6solo-riot.bin
kernel image	uImage
rootfs image	oneiric.tgz

Table 3-3 Storage Partitions for Linux

Partition type/index	Name	Start Offset	Size	File System	Content
N/A	BOOT Loader	0	1MB	N/A	u-boot-mx6solo-riot.bin
N/A	Kernel	1M	9MB	N/A	uImage
Primary 1	Rootfs	10M	Total - Other	EXT3	oneiric.tgz

- **Partition type/index:** defined in MBR.
- **Name:** only meaningful in Android. You can ignore it when creating these partitions.
- **Start Offset:** shows where partition starts with unit in MB.

3.3 Android System

The following tables list the specific images and eMMC storage patitions required to build an Android system.

Table 3-4 Images Required by Android

Images	Paths
u-boot image	u-boot-mx6solo-riot.bin
boot image	boot.img
Android system root image	system.img
Recovery root image	recovery.img

Table 3-5 Storage Partitions for Android

Partition type/index	Name	Start Offset	Size	File System	Content
N/A	BOOT Loader	0	1MB	N/A	bootloader
Primary 1	Boot	8M	8MB	boot.img format, a kernel + ramdisk	boot.img
Primary 2	Recovery	Follow Boot	8MB	boot.img format, a kernel + ramdisk	recovery.img
Logic 4 (Extended 3)	DATA	follow Recovery	> 1024MB	EXT4 Mount at /data	Application data storage for system application.
Logic 5 (Extended 3)	SYSTEM	Follow DATA	512MB	EXT4. Mount as /system	Android system files under /system/ dir
Logic 6 (Extended 3)	CACHE	follow SYSTEM	512MB	EXT4. Mount as /cache	Android cache, for image store for OTA
Logic 7(Extended 3)	VENDOR	follow CACHE	8MB	Ext4 Mount at /device	For Store MAC address files.
Logic 9 (Extended 3)	Misc	Follow DATA	8M	N/A	For recovery store bootloader message, reserve.
Primary 4	MEDIA	Follow Misc	Total - Other	VFAT	For internal media

Partition type/index	Name	Start Offset	Size	File System	Content
			images		partition, in /mnt/sdcard/ dir.

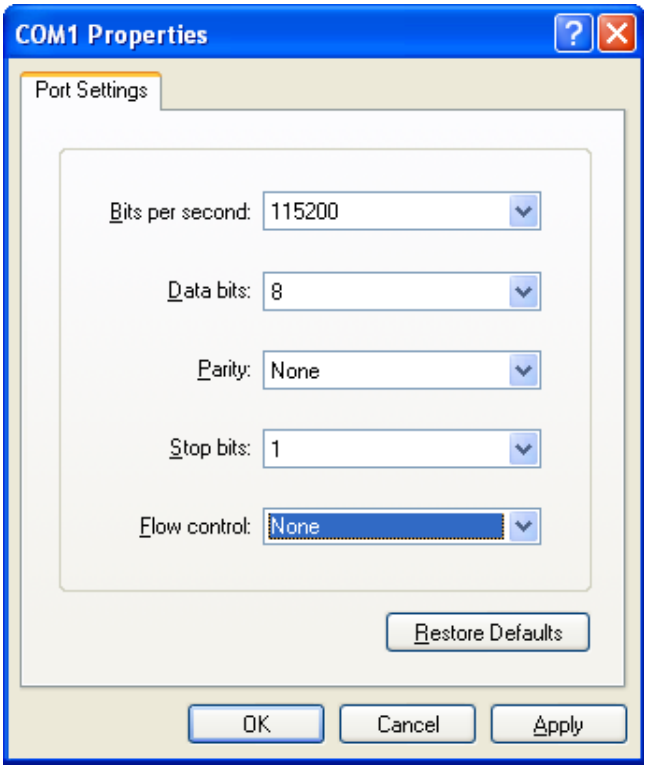
- **SYSTEM Partition:** used to store Android system image.
- **DATA Partition:** used to store applications' unpacked data, system configuration database, etc.

Under normal mode, the root file system is mounted from uramdisk. Under recovery mode, the root file system is mounted from the RECOVERY partition.

3.4 Setting up Terminal Emulation

Connect the RIoTboard to a PC with the help of a serial cable. Launch a terminal emulation program such as HyperTerminal or TeraTerm and configure the COM parameters as show below.

Figure 3-1 COM Properties



4 Downloading and Running the System

Now you can download the existing system to the RIoTboard and run it. The MFG tool saved under **linux\tools\ & android\tools** will be used to download images.

NOTE: All images and tools for Android and Linux can be downloaded from www.element14.com/riotboard

4.1 Download and Run Linux or Android System

1) Copy all the system files to a root directory of your hard drive (assume C:\ is the root directory).

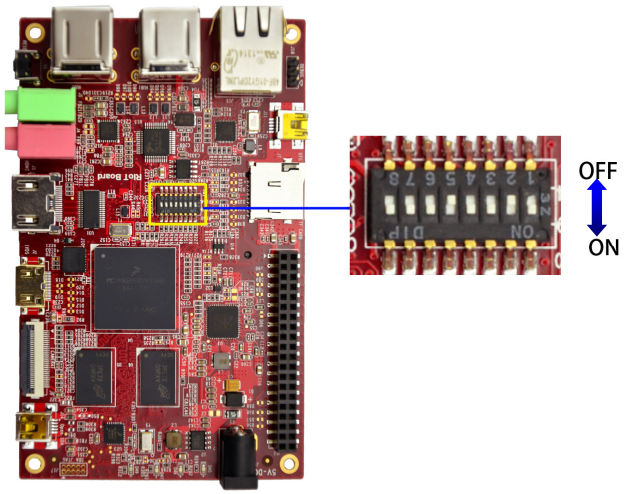
2) Use a Mini USB cable to connect USB OTG interface on RIoTboard to the USB Host on PC, and then open a Terminal window;

3) Set the boot switch SW1 on the RIoTboard to **Serial Download Mode** according to the configurations as shown in the following table;

Table 4-1 Boot Switch Configuration – Serial Download

Switch	D1	D2	D3	D4	D5	D6	D7	D8
SW1	OFF	ON	ON	ON	OFF	ON	ON	ON

Figure 4-1 Boot Configuration Switch



4) Modify the MFG tool configuration

Currently the Linux system on the RIoTboard supports only booting from eMMC, but the Android system supports booting from both eMMC and SD card. To select the device you want to program to, follow the instruction below:

Modify the value of "name" in cfg.ini under Android flash image tool **Mfgtools-Rel-4.1.0_130816_MX6DL_UPDATER** directory.

eMMC	--	name = Android-RIOT-eMMC
SD	--	name = Android-RIOT-SD

5) Prepare the image files

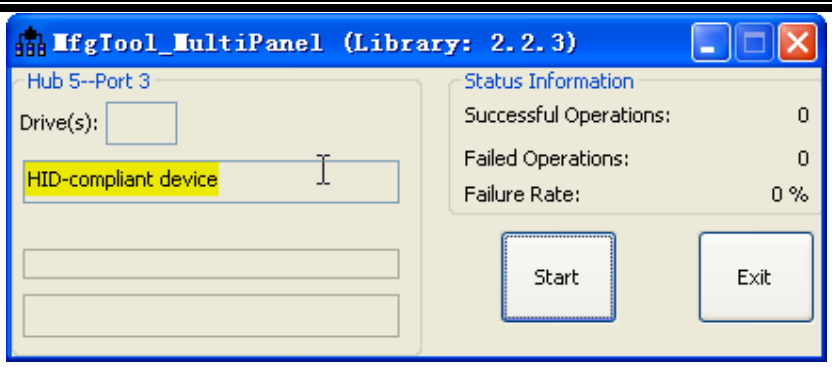
For Linux: Copy the Linux image files *oneiric.tgz*, *u-boot-mx6solo-riot.bin* and *uImage* to the Linux flash image tool **Mfgtools-Rel-4.1.0_130816_MX6DL_UPDATER\ Profiles\MX6DL Linux Update\OS Firmware\files** to overwrite the files with the same names

For Android: Copy the Android image files: u-boot-mx6solo-riot.bin and according to the boot mode (SD/eMMC) to copy the boot.img, recovery.img and system.img under SD/eMMC directory to Android flash image tool **Mfgtools-Rel-4.1.0_130816_MX6DL_UPDATER\ Profiles\MX6DL Linux Update\OS Firmware\files\android\,** for overwriting the files with the same names

6) According to the system you want to boot, run the corresponding MFG tool on your PC and power up the RIoTboard; the software window is shown below; (the PC will install HID driver automatically if it is the first time connecting to the RIoTboard)

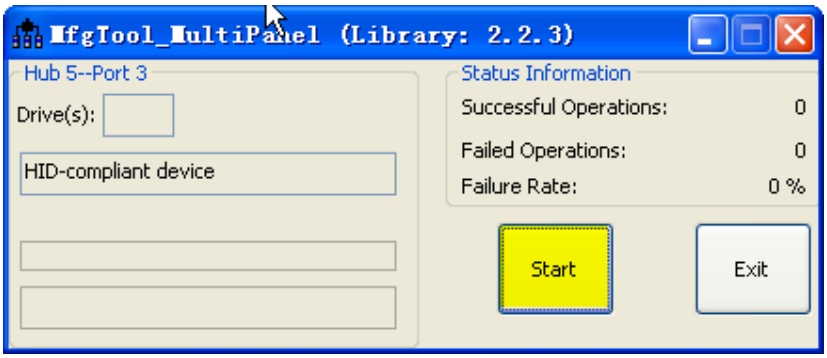
For Linux system, the MFG tool is located at :
linux\tools\Mfgtools-Rel-4.1.0_130816_MX6DL_UPDATER;

For Android system, the MFG tool is located at :
android\tools\Mfgtools-Rel-4.1.0_130816_MX6DL_UPDATER;



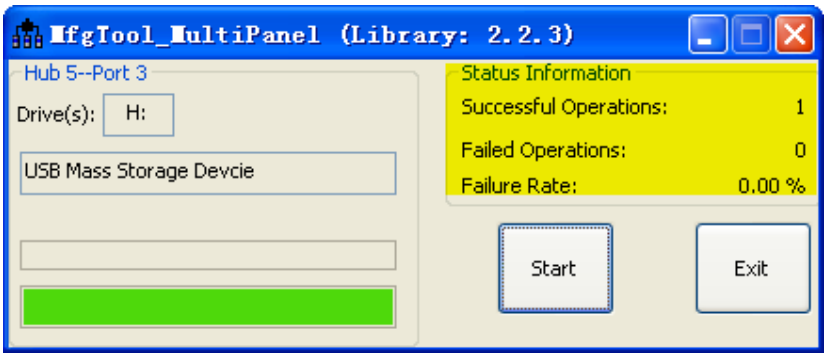
MFG tool window

7) Click **Start** in the following window; when download process is done, click **Stop** to finish.



Click Start

8) When download process is done, click **Exit** to exit.



9) Power off the RIoTboard and set the boot switches SW1 on it to eMMC boot mode according to the configuration as shown In the following table;

Table 4-2 Boot Switch Configuration - eMMC

Switch	D1	D2	D3	D4	D5	D6	D7	D8
SW1	ON	OFF	ON	ON	OFF	ON	ON	ON

Table 4-3 Boot Switch Configuration – SD

Switch	D1	D2	D3	D4	D5	D6	D7	D8
SW1	ON	OFF	ON	OFF	OFF	ON	OFF	ON

After the switch is set, power up the RIoTboard to boot the system.

4.2 Display Mode Configurations for Linux & Android Systems

The system supports multiple display modes. Users can select an appropriate mode by configuring u-boot parameters.

Please reboot the RIOT Board and press any key on your PC's keyboard when the system prompts you with a countdown in seconds as shown below:

```
U-Boot 2009.08-dirty (Oct 17 2013 - 17:08:06)

CPU: Freescale i.MX6 family TO1.1 at 792 MHz
Thermal sensor with ratio = 201
Temperature:   42 C, calibration data 0x5f55765f
mx6q pll1: 792MHz
mx6q pll2: 528MHz
mx6q pll3: 480MHz
mx6q pll8: 50MHz
ipg clock     : 66000000Hz
ipg per clock : 66000000Hz
uart clock    : 80000000Hz
cspi clock    : 60000000Hz
ahb clock     : 132000000Hz
axi clock   : 198000000Hz
emi_slow clock: 99000000Hz
ddr clock     : 396000000Hz
usdhc1 clock  : 198000000Hz
usdhc2 clock  : 198000000Hz
usdhc3 clock  : 198000000Hz
usdhc4 clock  : 198000000Hz
nfc clock     : 24000000Hz
Board: i.MX6DL/Solo-SABRESD: unknown-board Board: 0x61011 [POR ]
Boot Device: MMC
I2C:   ready
DRAM:   1 GB
MMC:   FSL_USDHC: 0,FSL_USDHC: 1,FSL_USDHC: 2,FSL_USDHC: 3
In:    serial
Out:   serial
Err:   serial
```

```
Net:   got MAC address from IIM: 00:00:00:00:00:00
----enet_board_init: phy reset
FEC0 [PRIME]
Hit any key to stop autoboot:  0 ( press any key to enter u-boot command mode )
MX6Solo RIOT U-Boot >
```

1) Display with 9.7” LVDS Only

Execute the following instructions in u-boot mode to configure for 9.7-inch display mode;

- MX6Solo RIOT U-Boot > **setenv bootargs console=ttymxc1,115200 init=/init nosmp video=mxcfb0:dev=ldb,bpp=32 video=mxcfb1:off fbmem=10M vmalloc=400M androidboot.console=ttymxc1 androidboot.hardware=freescale**
- MX6Solo RIOT U-Boot > **saveenv**

2) Display with HDMI Only (Default mode)

Execute the following instructions in u-boot mode to configure for HDMI display mode;

- MX6Solo RIOT U-Boot > **setenv bootargs console=ttymxc1,115200 init=/init nosmp video=mxcfb0:dev=hdmi,1280x720M@60,bpp=32 video=mxcfb1:off fbmem=10M vmalloc=400M androidboot.console=ttymxc1 androidboot.hardware=freescale**
- MX6Solo RIOT U-Boot > **saveenv**

5 Making Images

This Chapter will introduce how to make images by using BSP contained in the ISO. The BSP is a collection of binary, source code, and support files that can be used to create a u-boot bootloader, Linux kernel image, and Android file system for i.MX 6Solo RIOT Board.

Note:

- The following instructions are all executed under Ubuntu system.
- Each instruction has been put a bullets "•" before it to prevent confusion caused by the long instructions that occupy more than one line in the context.

5.1 Making Images for Linux

Please strictly follow the steps listed below to make images for Linux system.

5.1.1 Getting Tools and Source Code

1) Execute the following instructions to get cross compiling toolchain;

- **$ cd ~**
- **$ git clone git://github.com/embest-tech/fsl-linaro-toolchain.git**

2) Execute the following instructions to get u-boot source code;

- **$ cd ~**
- **$ git clone git://github.com/embest-tech/u-boot-imx.git –b embest_imx_3.0.35_4.0.0**

3) Execute the following instructions to get kernel source code;

- **$ cd ~**
- **$ git clone git://github.com/embest-tech/linux-imx.git -b embest_imx_3.0.35_4.0.0**

5.1.2 Compiling System Images

1) Execute the following instructions to compile u-boot image;

- **$ cd ~ /u-boot-imx**
- **$ export ARCH=arm**
- **$export CROSS_COMPILE=~/fsl-linaro-toolchain/bin/arm-fsl-linux-gnueabi-**
- **$ make distclean**
- **$ make mx6solo_riot_config**

- **$ make**
- **$ mv u-boot.bin u-boot-mx6solo-riot.bin**

After executing the instructions, a file u-boot-mx6solo-riot.bin can be found in the current directory ;

2） Execute the following instructions to compile kernel image;

- **$export PATH=~/u-boot-imx/tools:$PATH**
- **$ cd ~/linux-imx**
- **$ export ARCH=arm**
- **$export CROSS_COMPILE=~/ fsl-linaro-toolchain/bin/arm-fsl-linux-gnueabi-**
- **$ make imx6_defconfig**
- **$ make uImage**

After executing the instructions, a kernel image named uImage can be found under arch/arm/boot/.

Note:

📖 The mkimage is used to build the kernel and ramfs images are automatically generated and saved under tools/ after compiling u-boot.bin. So please make sure uboot is compiled first before compiling kernel image.

📖 Copy u-boot-mx6solo-riot.bin and uImage files that are generated by compiling to **linux flash image tool Mfgtools-Rel-4.1.0_130816_MX6DL_UPDATER\ Profiles\MX6DL Linux Update\OS Firmware\files** to overwrite the files with the same names and then start over the operations from step 2） in section 4.1 to verify the Linux system built.

5.2 Making Images for an Android System

Please strictly follow the steps listed below to make images for Android system.

5.2.1 Getting Repo Source Code

1） Execute he following instructions to get repo tool;

- $ **mkdir ~/bin**
- **$ curl https://raw.github.com/android/tools_repo/stable/repo > ~/bin/repo**
- $ **chmod a+x ~/bin/repo**
- $ **export PATH=~/bin:$PATH**

2) Execute the following instructions to initialize repo source code;

- $ **mkdir ~/android-imx6-jb4.3-1.0.0**
- $ **cd ~/android-imx6-jb4.3-1.0.0**
- $ **repo init --repo-url=git://github.com/android/tools_repo.git -u git://github.com/embest-tech/imx-manifest.git –m embest_android_jb4.3_1.0.0**

3) Execute the following instructions to synchronize repo source code;

- $ **cd ~/android-imx6-jb4.3-1.0.0**
- $ **repo sync**

5.2.2 Compiling System Images

1) You can choose to build Android image for eMMC or SD Boot:

Open the “device/fsl/riot_6solo/BoardConfig.mk” file with Notepad; change the “BUILD_TARGET_LOCATION” to select the boot device：

- eMMC Boot -- BUILD_TARGET_LOCATION ?= emmc
- SD Boot -- BUILD_TARGET_LOCATION ?= sdmmc

2) Execute the following instructions to compile Android image;

- $ **cd ~/android-imx6-jb4.3-1.0.0**
- $ **source build/envsetup.sh**
- $ **lunch riot_6solo-user**
- $ **make clean**
- $ **make**

After executing the instructions, the generated images can be found under android-imx6-jb4.3-1.0.0/out/target/product/riot_6solo/;

Table 5-1 shown below lists all the images and directories after compilation is completed.

Table 5-1 Images and Directories

Images/Directories	Notes
root/	root file system, mounted at /
system/	Android system directory, mounted at /system
data/	Android data area. mounted at /data
recovery/	Root filesystem when booting in "recovery" mode, not used directly
boot.img	A composite image which includes the kernel zImage, ramdisk, and boot parameters
ramdisk.img	Ramdisk image generated from "root/", not directly used
system.img	EXT4 image generated from "system/". Can be written to "SYSTEM" partition of SD/eMMC card with "dd" command
userdata.img	EXT4 image generated from "data/"
recovery.img	EXT4 image generated from "recovery/". Can be written to "RECOVERY" partition of SD/eMMC card with "dd" command
u-boot.bin	uboot image with padding

Note:

- Android image should be built in user mode;
- For more information, please visit http://source.android.com/source/building.html

3) Execute the following instructions to compile boot.img;

- **$ source build/envsetup.sh**
- **$ lunch riot_6solo-user**
- **$ make bootimage**

After executing the instructions, a boot.img image can be found under android-imx6-jb4.3-1.0.0/out/target/product/riot_6solo/.

Note:

- Copy the *boot.img*, *recovery.img*, *system.img* and *u-boot.bin* (**rename this to u-boot-mx6solo-riot.bin**) files created upon compilation, to the Android flash tool folder **Mfgtools-Rel-4.1.0_130816_MX6DL_UPDATER\ Profiles\MX6DL Linux Update\OS Firmware\files\android** to overwrite the files with the same names and repeat the operations from step 2) in 4.1 to verify the Android system built.

6 ESD PRECAUTIONS AND PROPER HANDLING PROCEDURES

This section includes the precautions for mechanical handling and static precautions to be taken to avoid ESD damage:

- Avoid carpets in cool, dry areas. Leave development kits in their anti-static packaging until ready to be installed.
- Dissipate static electricity before handling any system components (development kits) by touching a grounded metal object, such as the system unit unpainted metal chassis.
- If possible, use antistatic devices, such as wrist straps and floor mats.
- Always hold a evaluation board by its edges. Avoid touching the contacts and components on the board.
- Take care when connecting or disconnecting cables. A damaged cable can cause a short in the electrical circuit.
- Prevent damage to the connectors by aligning connector pins before you connect the cable. Misaligned connector pins can cause damage to system components at power-on.
- When disconnecting a cable, always pull on the cable connector or strain-relief loop, not on the cable itself.

USER MANUAL

XTRINSIC-SENSE Board

Evaluation Board for Freescale Xtrinsic Sensors

For use with Freescale FRDM-KL25z and Raspbery Pi Host Platforms

Exclusively from element14

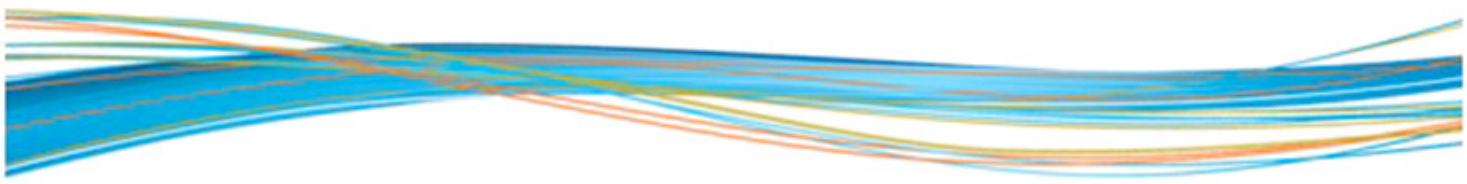


Table of Contents

KIT OVERVIEW 5
KIT CONTENTS: 5
Xtrinsic Sense Board 5
MPL3115 6
MAG3110 6
MMA8491Q 6
Pin Definition of Connectors 7
Board Top View 7
Pin Definition 7
Freescale Freedom FRDM-KL25Z 10
XTRINSIC-Sense board and FRDM-KL25Z 11
Pin mapping 11
Raspberry Pi 12
XTRINSIC-Sense board and Raspberry Pi 13
Pin mapping 13
DRIVERS FOR XTRINSIC SENSE BOARD 14
Driver for MPL3115A2 14
Driver Interfaces 14
Operation Modes 14
Data Acquisition 16
Raw Data Structure and Calculations 16
Alt Raw Data 16
Bar raw data 17
Temperature raw data 17
Drivers for MAG3110 17
Driver Interfaces 17
Raw Data Structure and calculations 18
X-Axis data 18
Y-Axis data 19
Z-Axis data 19
DEMONSTRATION W/ FRDM-KL25Z 20
Setup and Configuration 20
DEMONSTRATION W/ RASPBERRY PI 26
Setup and Configuration 26
Sensor Terminal Tests 27
Sensor Web Application Tests 29
Compass Application 30
Temperature Application 32
Running Car Application 33
MAKE YOUR OWN RPI IMAGE TO SUPPORT XTRINSIC-SENSE BOARD CONNECTION **34**

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

SET-UP 34
TERMINAL TESTS 34
WEB APPLICATION TESTS 35
HARDWARE 37
Schematic *38*
PCB Layout *42*
Bill of Materials *43*
ESD PRECAUTIONS AND PROPER HANDLING PROCEDURES 44

LIST OF FIGURES

FIGURE 1 - SENSOR BOARD 5
FIGURE 2 - SENSOR BOARD TOP VIEW 7
FIGURE 3 - FRDM-KL25Z BOARD 10
FIGURE 4 - PINOUTS OF I/O HEADERS ON FRDM-KL25Z 10
FIGURE 5 - XTRINSIC-SENSE BOARD W/ FRDM-KL25Z 11
FIGURE 6 - RASPBERRY PI BOARD 12
FIGURE 7 - PINOUTS OF I/O HEADERS ON RASPBERRY PI 12
FIGURE 8 - XTRINSIC-SENSE BOARD W/ RASPBERRY PI 13
FIGURE 12 - MPL3115 DEMO 23
FIGURE 13 - MAG3110 DEMO 24
FIGURE 14 - MMA8491Q DEMO 25
FIGURE 15 - SENSOR BOARD SCHEMATIC - 1 38
FIGURE 16 - SENSOR BOARD SCHEMATIC - 2 39
FIGURE 17 - SENSOR BOARD SCHEMATIC - 3 40
FIGURE 18 - SENSOR BOARD SCHEMATIC - 4 41
FIGURE 19 - SENSOR BOARD PCB TOP VIEW 42

LIST OF TABLES

TABLE 1 - CN1 FRDM-KL25Z DATA INTERFACE CONNECTOR 8
TABLE 2 - CN2 FRDM-KL25Z POWER SUPPLY CONNECTOR 8
TABLE 3 - CN3 RPI INTERFACE CONNECTOR 9
TABLE 4 - CN4 RPI UART INTERFACE CONNECTOR 9
TABLE 5 - MPL3115A2 INTERFACE LIST 14
TABLE 6 - MPL3115A2_ACTIVE 14
TABLE 7 - MPL3115A2_STANDBY 14
TABLE 8 - MPL3115A2_INIT_ALT 14
TABLE 9 - MPL3115A2_INIT_BAR 15
TABLE 10 - SYSTEM OUTPUT DATA RATE SELECTION 15
TABLE 11 - MPL3115A2_SETOSR 15
TABLE 12 - MPL3115A2_SETSTEPTIME 15
TABLE 13 - MPL3115A2_READ_ALT 16
TABLE 14 - MPL3115A2_READ_BAR 16

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

TABLE 15 - MPL3115A2_READ_TEMP 16
TABLE 16 - ALT RAW DATA STRUCTURE 16
TABLE 17 - BAR RAW DATA STRUCTURE 17
TABLE 18 - TEMPERATURE RAW DATA STRUCTURE 17
TABLE 19 - MAG3110 INTERFACE LIST 17
TABLE 20 - MAG3110_INIT 17
TABLE 21 - MAG3110_DEINIT 18
TABLE 22 - MAG3110_READRAWDATA_X 18
TABLE 23 - MAG3110_READRAWDATA_Y 18
TABLE 24 - MAG3110_READRAWDATA_Z 18
TABLE 25 - X-AXIS DATA STRUCTURE 18
TABLE 26 - Y-AXIS DATA STRUCTURE 19
TABLE 27 - Z-AXIS DATA STRUCTURE 19
TABLE 28 - XTRINSIC-SENSE BOARD BOM LIST 43

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Kit Overview

The XTRINSIC-SENSE board demonstrates the capabilities of Freescale's Xtrinsic sensors. The Xtrinsic Sensor board includes interfacing and support for the following host platforms:

- Freescale FRDM-KL25Z
- Raspberry Pi (Model B)

The software drivers and code enable engineers to easily evaluate and demonstrate the performance of the sensors in a variety of applications including:

- eCompass
- Mobile Phones/Tablet Computers
- Remote Control/Wireless Mouse
- Game Consoles
- Navigation Devices
- Medical Devices

Kit Contents:

- Xtrinsic Sense Board
- Quick Start Guide

Xtrinsic Sense Board

The sensor board comes equipped with three of Freescale's new-generation XTRINSIC MEMS sensors. The **MPL3115** (U1) is designed for accurate measurement of temperature and pressure, the **MAG3110** (U2) for detection of magnetic fields, and the **MMA8491** (U3) for measurement of physical positions.

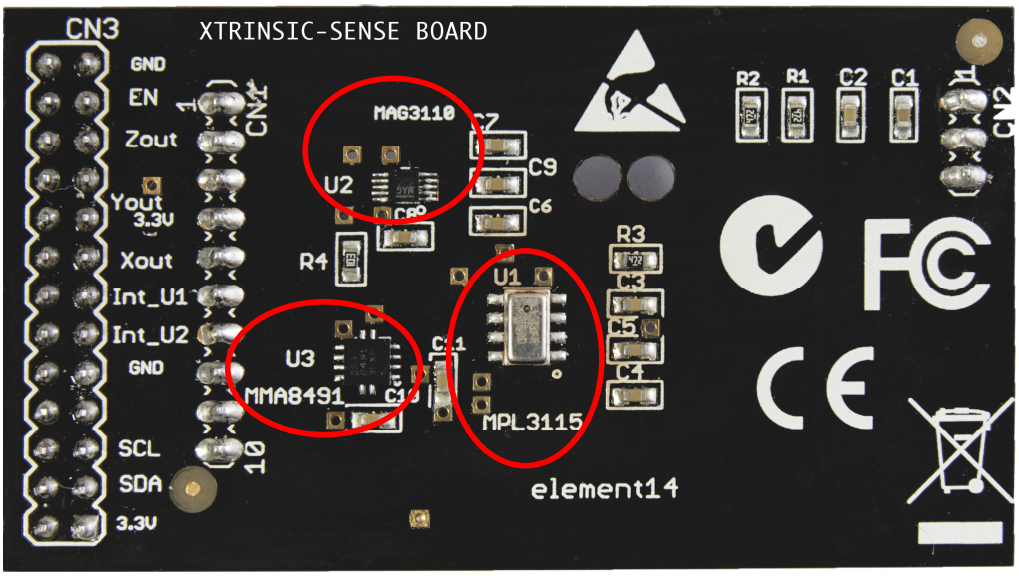


Figure 1 - Sensor Board

MPL3115

The MPL3115 is a high-precision sensor used to provide accurate pressure and altitude data. It features an adjustable sampling rate, ultra-low power consumption and intelligent functions, suitable for applications such as mobile, medical and security devices. MPL3115 is able to provide digitized output, two separated wake-up interrupts, minimum/maximum threshold mechanism, and autonomous data acquisition. The self data processing ability of the MPL3115 reduces the need for communication with MCUs, which reduces overall system power consumption.

MAG3110

The MAG3110 is a small, low-power, digital 3-axis magnetometer featuring a wide measurement range. It can measure magnetic fields (the overlapped fields consisting of the geomagnetic field and the fields created by components on PCB) on each of the 3 axes in the position where it is placed. The MAG3110 features an I2C serial interface, and is capable of measuring magnetic fields of up to 10 Gauss with an output data rate up to 80Hz. The output data rate can vary depending on the sampling intervals and may be adjusted from 12ms to several seconds.

MMA8491Q

The MMA8491Q is a low voltage, 3-axis low-g accelerometer housed in a 3 mm by 3 mm QFN package. The device can accommodate two accelerometer configurations, acting as either an easy to implement 45° Tilt Sensor or a digital (I2C) output accelerometer. In the 45° Tilt Sensor mode, it offers extremely easy board implementation by using a single line of output per axis. In the digital output mode, 14-bit ±8g raw data can be read from the device with high 1 mg/LSB sensitivity. The extreme low power capabilities of the MMA8491Q reduce the low data rate current consumption to less than 400 nA per Hz.

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Pin Definition of Connectors

This section will briefly introduce the connectors used on sensor board and the pins of these connectors in terms of definition, function and application.

Board Top View

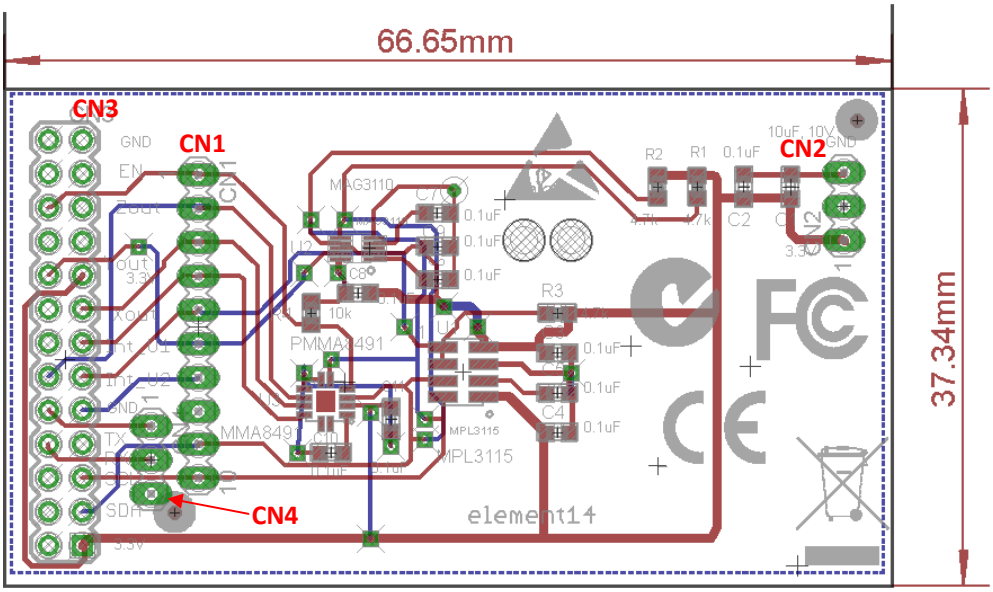


Figure 2 - Sensor Board Top View

Pin Definition

CN1 – Used for interface with FRDM-KL25z host platform

Pin No.	Pin Name	Description
1	EN	MMA8491 Enable Pin
2	ZOUT	MMA8491 Push-Pull Z-Axis Tilt Detection Output
3	YOUT	MMA8491 Push-Pull Y-Axis Tilt Detection Output
4	XOUT	MMA8491 Push-Pull X-Axis Tilt Detection Output
5	INT_MPL3115	MPL3115 Interrupt
6	INT_MAG3110	MAG3110 Interrupt
7	GND	Ground
8	NC	No Connection
9	SDA_SENSOR	I2C Slave Data Line
10	SCL_SENSOR	I2C Slave Clock Line

Table 1 - CN1 FRDM-KL25z Data Interface Connector

CN2:FRDM-KL25z Power Supply Connector

Pin No.	Pin Name	Description
1	VDD	+3.3V DC Power Supply
2	NC	No Connection
3	GND	Ground

Table 2 - CN2 FRDM-KL25z Power Supply Connector

CN3 – Raspberry Pi Interface

Pin No.	Pin Name	Description
1	VDD	+3.3V DC Power Supply
2	NC	No Connection
3	SDA_SENSOR	I2C Slave Data Line
4	NC	No Connection
5	SCL_SENSOR	I2C Slave Clock Line
6	GND	Ground
7	NC	No Connection
8	TX	RPi UART TXD0
9	GND	Ground
10	RX	RPi UART RXD0
11	INT_MPL3115	MPL3115 Interrupt
12	ZOUT	MMA8491 Push-Pull Z-Axis Tilt Detection Output
13	XOUT	MMA8491 Push-Pull X-Axis Tilt Detection Output
14	GND	Ground
15	YOUT	MMA8491 Push-Pull Y-Axis Tilt Detection Output
16	NC	No Connection
17	VDD	+3.3V DC Power Supply

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

18	INT_MAG3110	MAG3110 Interrupt
19	NC	No Connection
20	GND	Ground
21	NC	No Connection
22	EN	MMA8491 Enable Pin
23	NC	No Connection
24	NC	No Connection
25	GND	Ground
26	NC	No Connection

Table 3 - CN3 RPi Interface Connector

CN4: RPi UART Interface

Pin No.	Pin Name	Description
1	RX	RPi UART RXD0
2	TX	RPi UART TXD0
3	GND	Ground

Table 4 - CN4 RPi UART Interface Connector

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Freescale Freedom FRDM-KL25Z

The FRDM-KL25Z features a KL25Z128VLK - a KL2 family device boasting a max operating frequency of 48MHz, 128KB of flash, a full-speed USB controller, and loads of analog and digital peripherals. The FRDM-KL25Z has an easy access to MCU I/O via Arduino ™ R3 compatible I/O connectors.

The board also features a programmable OpenSDA debug interface with multiple applications available including:

- Mass storage device flash programming interface
- P&E Debug interface provides run-control debugging and compatibility with IDE tools
- CMSIS-DAP interface: new ARM standard for embedded debug interface

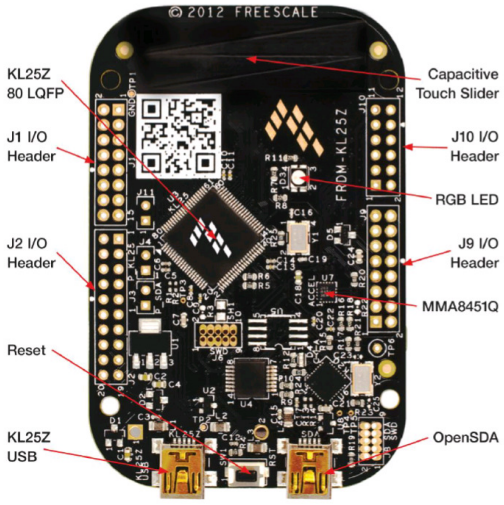


Figure 3 - FRDM-KL25Z board

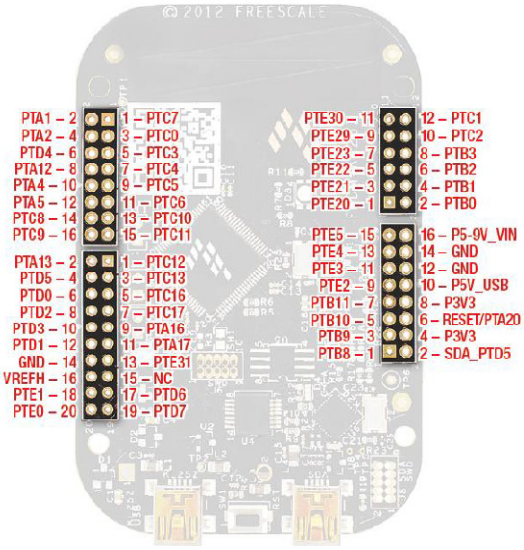


Figure 4 - Pinouts of I/O headers on FRDM-KL25Z

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

XTRINSIC-Sense board and FRDM-KL25Z

Pin mapping

Sensor Board CN1		FRDM KL25Z J2	
EN	1	2	PTA13
Z_{OUT}	2	4	PTD5
Y_{OUT}	3	6	PTD0
X_{OUT}	4	8	PTD2
INT_U1	5	10	PTD3
INT_U2	6	12	PTD1
GND	7	14	GND
NC	8	16	VREFH
SDA	9	18	PTE1
SCL	10	20	PTE0

Sensor Board CN2		FRDM KL25Z J9	
GND	3	12	GND
NC	2	10	P5V_USB
VDD	1	8	P3V3

Figure 5 - XTRINSIC-SENSE Board w/ FRDM-KL25Z

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Raspberry Pi

The Raspberry Pi features a BCM2835 SoC which includes an ARM1176JZF-S 700MHz processor, VideoCore IV GPU, and 512 MB of RAM (Model B). It also includes two USB ports and a 10/100 Ethernet controller. The Raspberry Pi has an easy access 26-pin GPIO I/O header (2x13, 0.1" center). Four additional GPIO available on P5. The board also features primary and secondary I^2C channels.

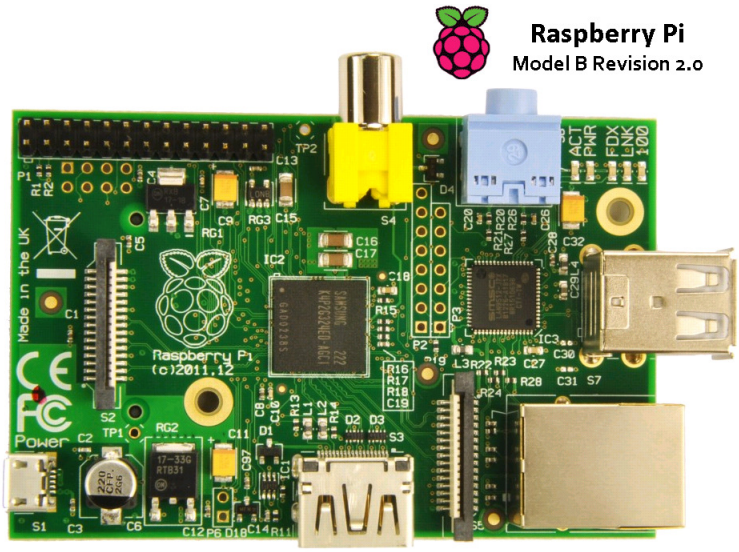


Figure 6 - Raspberry Pi board

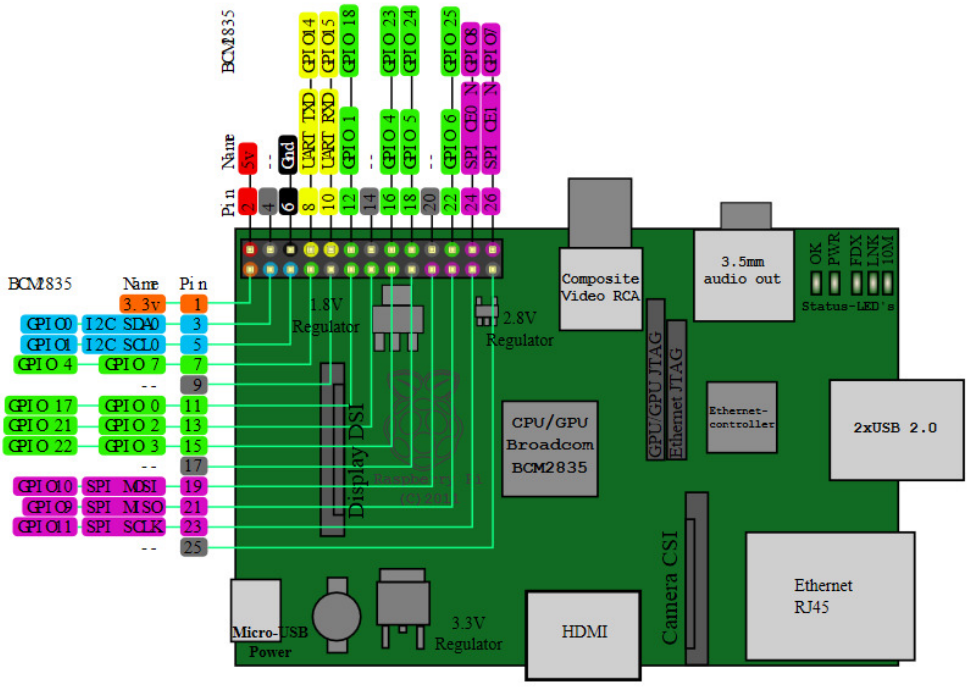


Figure 7 - Pinouts of I/O headers on Raspberry Pi

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

XTRINSIC-Sense board and Raspberry Pi

Pin mapping

Sensor Board	CN3	P1	Raspberry Pi
+3V3	1	1	1 – +3V3
SDA_SENSOR	3	3	3 – SDA1
SCL_SENSOR	5	5	5 – SCL1
nc	7	7	7 – GPIO_GCLK
GND	9	9	9 – GND
INT_MPL3115	11	11	11 – GPIO_GEN0
XOUT	13	13	13 – GPIO_GEN2
YOUT	15	15	15 – GPIO_GEN3
+3V3	17	17	17 – +3V3
nc	19	19	19 – SPI_MOSI
nc	21	21	21 – SPI_MISO
nc	23	23	23 – SPI_SCLK
GND	25	25	25 – GND

Sensor Board	CN3	P1	Raspberry Pi
nc	2	2	2 – +5V0
nc	4	4	4 – +5V0
GND	6	6	6 – GND
TX	8	8	8 – TXD0
RX	10	10	10 – RXD0
ZOUT	12	12	12 – GPIO_GEN1
GND	14	14	14 – GND
nc	16	16	16 – GPIO_GEN4
INT_MAG3110	18	18	18 – GPIO_GEN5
GND	20	20	20 – GND
EN	22	22	22 – GPIO_GEN6
nc	24	24	24 – SPI_CE0_N
nc	26	26	26 – SPI_CE1_N

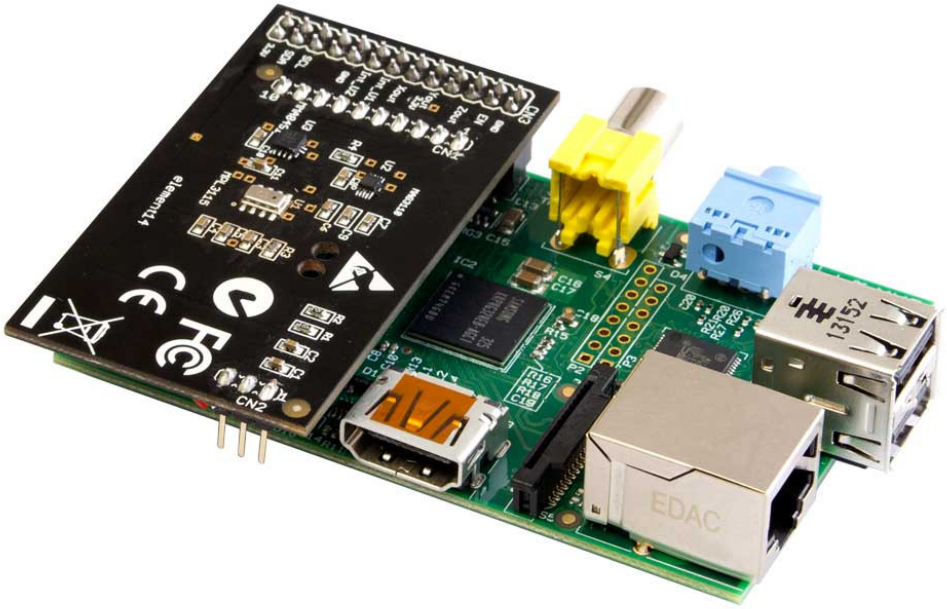


Figure 8 - XTRINSIC-SENSE Board w/ Raspberry Pi

Drivers for Xtrinsic Sense Board

Driver for MPL3115A2

Driver Interfaces

The MPL3115A2 features three kinds of modes, 8 different sample rates, 16 different acquisition time steps (1 second to 9 hours), and compensated direct reading of pressure (20 bit in Pascal) or altitude (20 bit in meters). The driver provides the following interfaces for implementing these features.

Table 5 - MPL3115A2 Interface list

1	Modes of Operation	void MPL3115A2_Active (void)
2		Uint8_t MPL3115A2_Standby (void)
3		Uint8_t MPL3115A2_Init_Alt (void)
4		Uint8_t MPL3115A2_Init_Bar (void)
5	Over sample	void MPL3115A2_SetOSR (uint8_t)
6		void MPL3115A2_SetStepTime (uint8_t)
7	Read raw data	uint32_t MPL3115A2_Read_Alt (void)
8		uint32_t MPL3115A2_Read_Bar (void)
9		uint32_t MPL3115A2_Read_Temp (void)

Operation Modes

MPL3115A2 has three operation modes: Standby, Active Altitude, and Active Barometer. These modes can be implemented using the following interfaces.

Table 6 - MPL3115A2_Active

Name	MPL3115A2_Active
Prototype	void MPL3115A2_Active (void)
Param	Void
Return Value	Void
Description	Put MPL3115A2 into Active Mode

Table 7 - MPL3115A2_Standby

Name	MPL3115A2_Standby
Prototype	Uint8_t MPL3115A2_Standby (void)
Param	Void
Return Value	The value of CTRL_REG1 before modification
Description	Put MPL3115A2 into Standby Mode

Table 8 - MPL3115A2_Init_Alt

Name	MPL3115A2_Init_Alt
Prototype	Uint8_t MPL3115A2_Init_Alt (void)
Param	Void
Return Value	0 – fail, 1 – success
Description	Initialize MPL3115A2 for Alt mode

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Table 9 - MPL3115A2_Init_Bar

Name	MPL3115A2_Init_Bar
Prototype	Uint8_t MPL3115A2_Init_Bar (void)
Param	Void
Return Value	0 – fail, 1 – success
Description	Initialize MPL3115A2 for Bar mode

Over Sampling

Output Sample Rate can be set as shown in Table 10 - System Output Data Rate Selection. Table 10 and 11 contain the functions used for configuring over-sampling parameters.

Table 10 - System Output Data Rate Selection

OSR	Oversample Ratio	Minimum Time Between Data Samples
0	1	2.5 ms
1	2	5 ms
2	4	10 ms
3	8	20 ms
4	16	40 ms
5	32	80 ms
6	64	160 ms
7	128	320 ms

Table 11 - MPL3115A2_SetOSR

Name	MPL3115A2_SetOSR
Prototype	void MPL3115A2_SetOSR (uint8_t osr)
Param	OSR Ratio
Return Value	Void
Description	Change the OSR Ratio

Table 12 - MPL3115A2_SetStepTime

Name	MPL3115A2_SetStepTime
Prototype	void MPL3115A2_SetStepTime (uint8_t step)
Param	Sample Step = 2^step;
Return Value	Void
Description	Change sample step

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Data Acquisition

Pressure (20 bit in Pascals), Altitude (20 bit in meters), and Temperature (12 bit in degrees Celsius) can be read by functions contained in the following tables, and be calculated using the formulas in section 0

Table 13 - MPL3115A2_Read_Alt

Name	MPL3115A2_Read_Alt
Prototype	uint32_t MPL3115A2_Read_Alt (void)
Param	Void
Return Value	The raw data for Altitude:
Description	Read Altitude data from MPL3115A2

Table 14 - MPL3115A2_Read_Bar

Name	MPL3115A2_Read_Bar
Prototype	uint32_t MPL3115A2_Read_Bar (void)
Param	Void
Return Value	The raw data for Barometer
Description	Read Barometer data from MPL3115A2

Table 15 - MPL3115A2_Read_Temp

Name	MPL3115A2_Read_Temp
Prototype	uint32_t MPL3115A2_Read_Temp (void)
Param	Void
Return Value	The raw data for temperature
Description	Read Temperature data from MPL3115A2

Raw Data Structure and Calculations

Alt Raw Data

Table 16 - Alt raw data structure

31 … 24	23 … 16	15 … 8	7 … 0
Invalid	ALT_MSB	ALT_CSB	ALT_LSB

Integer part: ALT_MSB x 2^8 + ALT_CSB
Decimal part: (ALT_LSB / 2^4) x 0.0625

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Bar raw data

Table 17 - Bar raw data structure

31 … 24	23 … 16	15 … 8	7 … 0
Invalid	BAR_MSB	BAR_CSB	BAR_LSB

Integer part: (BAR_MSB x 2^{16} + BAR_CSB x 2^{8} + BAR_LSB) / 2^{6}

Decimal part: BAR_LSB.BIT5 x0.5 + BAR_LSB.BIT4 x 0. 25

Temperature raw data

Table 18 - Temperature raw data structure

31 … 24	23 … 16	15 … 8	7 … 0
Invalid	Invalid	T_MSB	T_LSB

Integer part: T_MSB

Decimal part: (T_LSB / 2^{4}) x 0.0625

Drivers for MAG3110

Driver Interfaces

MAG3110 is a digital 3-axis magnetometer from which the data can be read using interfaces contained in Table 19 to Table 24

Table 19 - MAG3110 Interface list

1	Initialize	Uint8_t MAG3110_Init(void)
2		void MAG3110_DeInit(void)
3	Read raw data	uint32_t MAG3110_ReadRawData_x(void)
6		uint32_t MAG3110_ReadRawData_y(void)
7		uint32_t MAG3110_ReadRawData_z(void)

Table 20 - MAG3110_Init

Name	MAG3110_Init
Prototype	Uint8_t MAG3110_Init(void)
Param	Void
Return Value	0 – fail, 1 – success
Description	Initialize MAG3110

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Table 21 - MAG3110_DeInit

Name	MAG3110_DeInit
Prototype	void MAG3110_DeInit(void)
Param	Void
Return Value	Void
Description	Deinitialize MAG3110

Table 22 - MAG3110_ReadRawData_x

Name	MAG3110_ReadRawData_x
Prototype	uint32_t MAG3110_ReadRawData_x(void)
Param	Void
Return Value	Raw data for x-axis
Description	Read x-axis data from MAG3110

Table 23 - MAG3110_ReadRawData_y

Name	MAG3110_ReadRawData_y
Prototype	uint32_t MAG3110_ReadRawData_y(void)
Param	Void
Return Value	Raw data for y-axis
Description	Read y-axis data from MAG3110

Table 24 - MAG3110_ReadRawData_z

Name	MAG3110_ReadRawData_z
Prototype	uint32_t MAG3110_ReadRawData_z(void)
Param	Void
Return Value	Raw data for z-axis
Description	Read x-axis data from MAG3110

Raw Data Structure and calculations

X-Axis data

X-axis 16-bit output sample data of the magnetic field strength is expressed as signed 2's complement.

Table 25 - X-Axis data structure

31	24	23	16	15	8	7	0
Invalid		Invalid		X_MSB		X_LSB	

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Scale factor
Data (in µT unit) = Data(Count) x 0.1

Y-Axis data

Y-axis 16-bit output sample data of the magnetic field strength is expressed as signed 2's complement.

Table 26 - Y-Axis data structure

31 … 24	23 … 16	15 … 8	7 … 0
Invalid	Invalid	Y_MSB	Y_LSB

Z-Axis data

Z-axis 16-bit output sample data of the magnetic field strength is expressed as signed 2's complement.

Table 27 - Z-Axis data structure

31 … 24	23 … 16	15 … 8	7 … 0
Invalid	Invalid	Z_MSB	Z_LSB

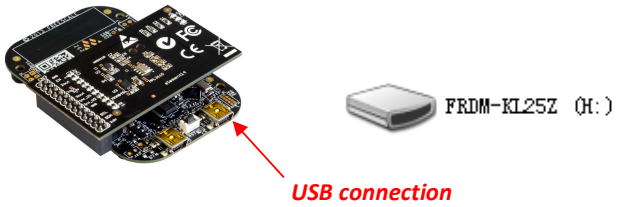
Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Demonstration w/ FRDM-KL25Z

After the driver code is loaded onto the Freedom KL25Z, the sensor features can be demonstrated with a command line interface of HyperTerminal, or another UART tools.

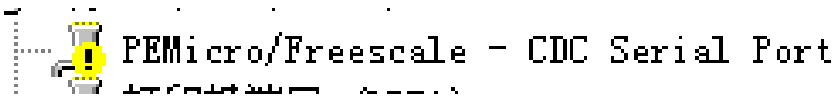
Setup and Configuration

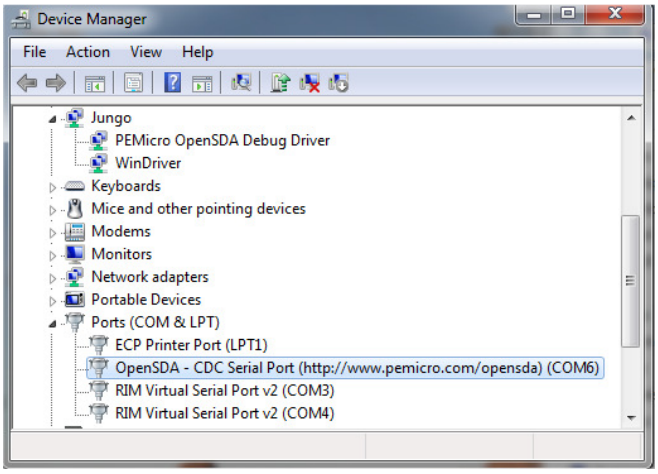
1. Plug in a USB cable from a USB host to the OpenSDA mini-B USB connector of the FRDM-KL25Z. The FRDM-KL25Z will be powered by this USB connection. FRDM-KL25Z comes with the mass-storage device (MSD) Flash Programmer OpenSDA Application preinstalled. It will appear as a removable storage drive with a volume label of `FRDM-KL25Z`. (Note: For more details on setup of the FRDM-KL25Z please refer to http://www.element14.com/community/docs/DOC-49219)



2. Open the FRDM-KL25Z drive, and drop the image "sensors_freedom.srec" into it, as seen below.

3. The MSD Flash Programmer also includes a USB virtual serial port which requires an `.INF` file for proper installation in Windows. The necessary `.INF` file is available as part of the P&E OpenSDA USB Drivers and on the `FRDM-KL25Z` removable drive.

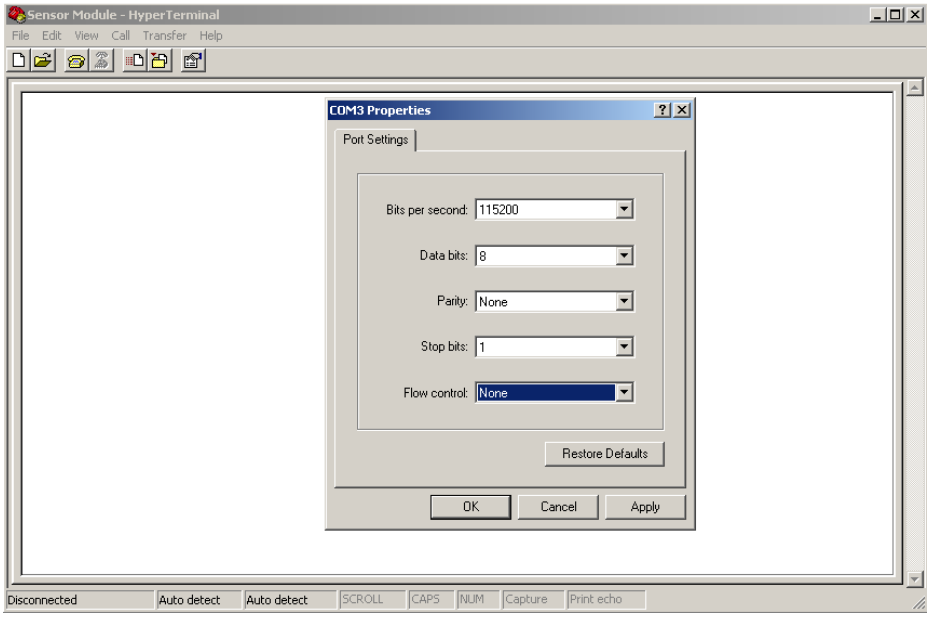




The serial port will be configured after the driver installation – eg. COM6 in the example.

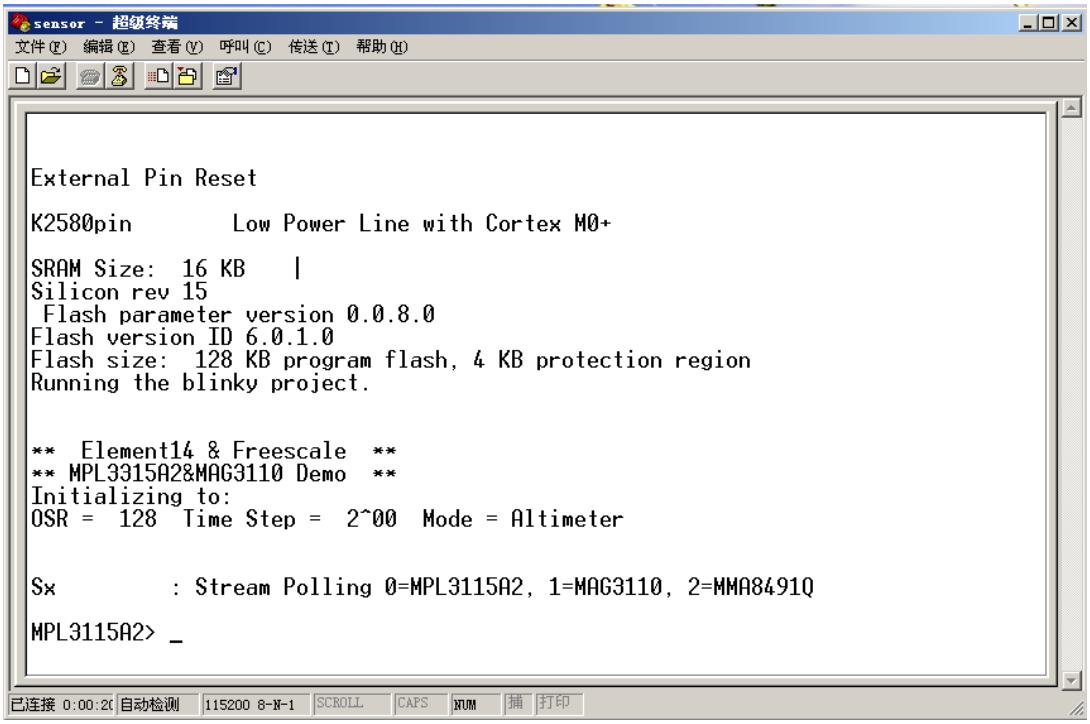
4. Launch the terminal program (eg. Tera Term) with the properties as follows:

Baud rate	115200
Data bits	8-bit
Stop bits	1-bit
Parity	None
Flow control	None

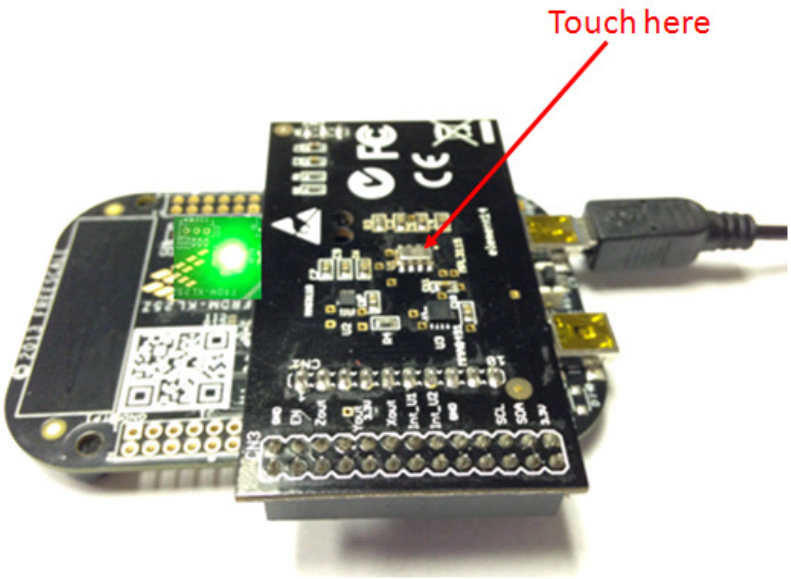


© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

5. Reset the board by pressing the reset button (SW1), and you can see the information displayed below


sensor - 超级终端
文件(F) 编辑(E) 查看(V) 呼叫(C) 传送(T) 帮助(H)
External Pin Reset
K2580pin Low Power Line with Cortex M0+
SRAM Size: 16 KB
Silicon rev 15
Flash parameter version 0.0.8.0
Flash version ID 6.0.1.0
Flash size: 128 KB program flash, 4 KB protection region
Running the blinky project.
** Element14 & Freescale **
** MPL3315A2&MAG3110 Demo **
Initializing to:
OSR = 128 Time Step = 2^00 Mode = Altimeter
Sx : Stream Polling 0=MPL3115A2, 1=MAG3110, 2=MMA8491Q
MPL3115A2> _
已连接 0:00:2(自动检测 115200 8-N-1 SCROLL CAPS NUM 捕 打印

6. Type 'S0' into the terminal through the PC keyboard, to try out the MPL3115A2 sensor. The terminal will begin to display temperature readings. Touch the sensor with your finger and notice that the temperature readings will start to rise. At the same time, the RGB LED will begin blinking red.



© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

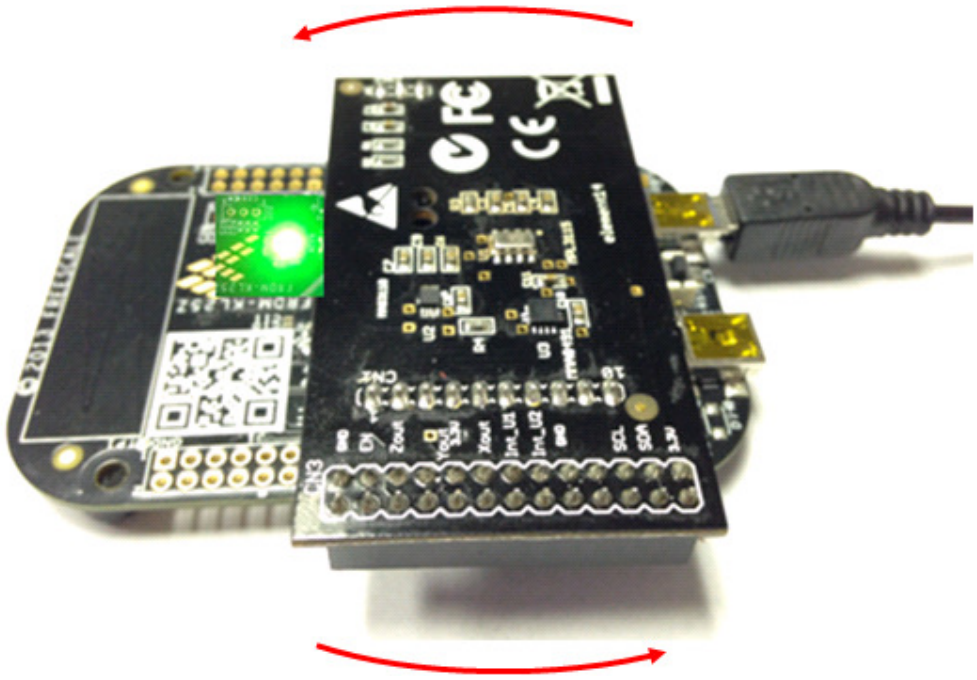
```
Sx          : Stream Polling 0=MPL3115A2, 1=MAG3110, 2=MMA8491Q

MPL3115A2> S0
MPL3115:        Alt. +  51.5625 Temp+ 24.0625
MPL3115:        Alt. +  51.6875 Temp+ 24.0625
MPL3115:        Alt. +  51.8750 Temp+ 24.0625
MPL3115:        Alt. +  51.8750 Temp+ 24.0625
MPL3115:        Alt. +  51.3750 Temp+ 24.0625
MPL3115:        Alt. +  51.3750 Temp+ 24.0625
MPL3115:        Alt. +  51.5000 Temp+ 24.0625
MPL3115:        Alt. +  48.8750 Temp+ 24.8125
MPL3115:        Alt. +   9.4375 Temp+ 25.3125
MPL3115:        Alt. -  22.0625 Temp+ 25.6250
MPL3115:        Alt. -  40.2500 Temp+ 25.8125
MPL3115:        Alt. -  62.0625 Temp+ 26.0000
MPL3115:        Alt. -  52.6875 Temp+ 26.0625
MPL3115:        Alt. -  63.5625 Temp+ 26.1250
MPL3115:        Alt. -  64.4375 Temp+ 26.2500
MPL3115:        Alt. -  78.3750 Temp+ 26.3125
MPL3115:        Alt. -  75.0625 Temp+ 26.3750
MPL3115:        Alt. -  84.6250 Temp+ 26.5000_
```

The temperature will rise when sensor is touched

Figure 9 - MPL3115 demo

7. Press the "Enter" key on the keyboard to quit the demo and go back to the menu. Type ‘S1’ to try out the MAG3110 sensor. Shake the board around, and you can see the 3-D magnetic field measurement change. At the same time, the RGB LED will begin blinking green.



Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

```
MAG3110:        X.-   8uT       Y.+  11uT       Z.-  30uT
MAG3110:        X.-   9uT       Y.+  10uT       Z.-  31uT
MAG3110:        X.-  11uT       Y.+   8uT       Z.-  32uT
MAG3110:        X.-  11uT       Y.+   5uT       Z.-  33uT
MAG3110:        X.-   9uT       Y.+   0uT       Z.-  32uT
MAG3110:        X.-   5uT       Y.-   1uT       Z.-  33uT
MAG3110:        X.-   3uT       Y.-   2uT       Z.-  32uT
MAG3110:        X.-   1uT       Y.-   1uT       Z.-  31uT
MAG3110:        X.+   0uT       Y.+   0uT       Z.-  30uT
MAG3110:        X.+   1uT       Y.+   2uT       Z.-  27uT
MAG3110:        X.+   1uT       Y.+   1uT       Z.-  31uT
MAG3110:        X.+   0uT       Y.+   0uT       Z.-  28uT
MAG3110:        X.-   3uT       Y.+   0uT       Z.-  30uT
MAG3110:        X.-   7uT       Y.+   1uT       Z.-  31uT
MAG3110:        X.-  10uT       Y.+   5uT       Z.-  30uT
MAG3110:        X.-  10uT       Y.+  10uT       Z.-  29uT
MAG3110:        X.-   7uT       Y.+  12uT       Z.-  29uT
MAG3110:        X.-   4uT       Y.+  12uT       Z.-  30uT
MAG3110:        X.-   2uT       Y.+  12uT       Z.-  28uT
MAG3110:        X.-   1uT       Y.+  12uT       Z.-  30uT
MAG3110:        X.-   2uT       Y.+  12uT       Z.-  27uT
MAG3110:        X.-   2uT       Y.+  13uT       Z.-  30uT
MAG3110:        X.-   2uT       Y.+  13uT       Z.-  29uT
MAG3110:        X.-   2uT       Y.+  13uT       Z.-  30uT_
```

Figure 10 - MAG3110 Demo

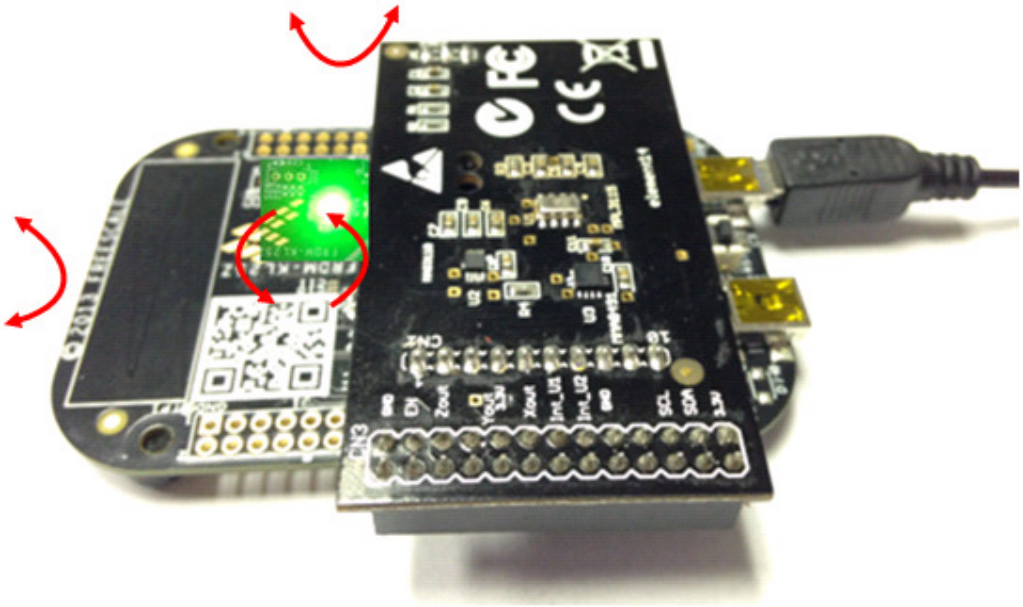
8. Press the "Enter" key on the keyboard to return the menu, and type ‘S2’ to try out the MMA8491Q sensor

```
Sx          : Stream Polling 0=MPL3115A2, 1=MAG3110, 2=MMA8491Q

MPL3115A2> S2
```

Turn the board from side to side and from front to back to see the corresponding x, y, and z coordinates change as the board is tilted. At the same time, the RGB LED will begin blinking blue.

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.



```
MMA8491Q:      X.- 129mg      Y.- 652mg      Z.+ 618mg
MMA8491Q:      X.- 220mg      Y.- 909mg      Z.+ 479mg
MMA8491Q:      X.-  38mg      Y.-1136mg      Z.+ 458mg
MMA8491Q:      X.+  33mg      Y.- 696mg      Z.+ 593mg
MMA8491Q:      X.+  36mg      Y.- 306mg      Z.+1001mg
MMA8491Q:      X.+  73mg      Y.+ 297mg      Z.+ 930mg
MMA8491Q:      X.+ 101mg      Y.+ 881mg      Z.+ 486mg
MMA8491Q:      X.+  14mg      Y.+1320mg      Z.+ 121mg
MMA8491Q:      X.+ 120mg      Y.+1203mg      Z.+  67mg
MMA8491Q:      X.+  99mg      Y.+ 491mg      Z.+ 506mg
MMA8491Q:      X.-  78mg      Y.-  17mg      Z.+1171mg
MMA8491Q:      X.-  50mg      Y.-   1mg      Z.+ 909mg
MMA8491Q:      X.- 131mg      Y.-  89mg      Z.+ 976mg
MMA8491Q:      X.- 184mg      Y.-  29mg      Z.+1175mg
MMA8491Q:      X.-  87mg      Y.+  70mg      Z.+ 904mg
MMA8491Q:      X.-  95mg      Y.-  74mg      Z.+1026mg
MMA8491Q:      X.-  72mg      Y.+  33mg      Z.+1057mg
MMA8491Q:      X.-  84mg      Y.+   0mg      Z.+1036mg
MMA8491Q:      X.-  88mg      Y.+  33mg      Z.+1002mg
MMA8491Q:      X.-  76mg      Y.+  24mg      Z.+1015mg
MMA8491Q:      X.-  71mg      Y.+  49mg      Z.+1017mg
MMA8491Q:      X.-  88mg      Y.+  50mg      Z.+ 986mg
MMA8491Q:      X.- 118mg      Y.+  30mg      Z.+1023mg
MMA8491Q:      X.- 153mg      Y.+  64mg      Z.+ 987mg_
```

已连接 0:14:4 | 自动检测 | 115200 8-N-1 | SCROLL | CAPS | NUM | 捕 | 打印

Figure 11 - MMA8491Q Demo

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Demonstration w/ Raspberry Pi

The demonstrations detailed below include set-up and programming of the Raspberry Pi specifically for use with the XTRINSIC-SENSE BOARD.

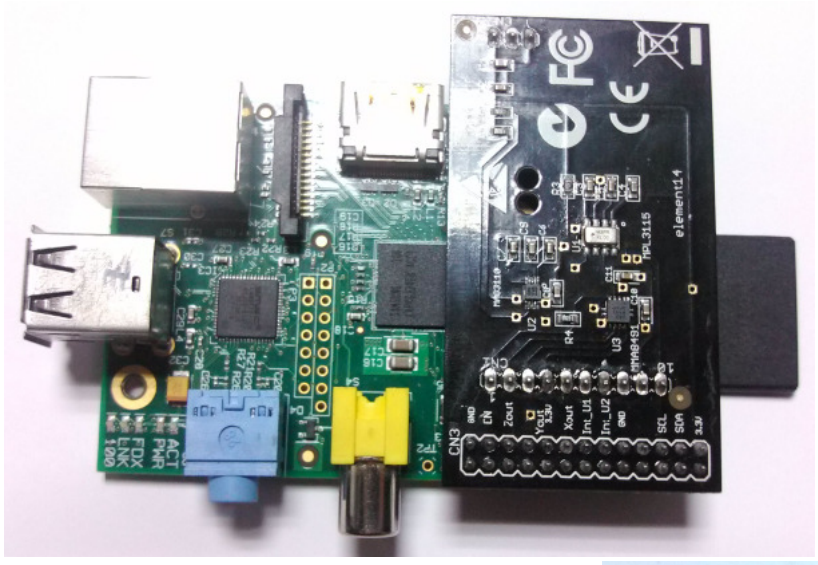
The demonstrations include terminal level demonstrations and web applications demonstrations. Note, the web application demonstrations require a network connection. These demonstrations are enabled though a supplied custom image file for Raspberry Pi to support connection to the XTRINSIC-SENSE BOARD.

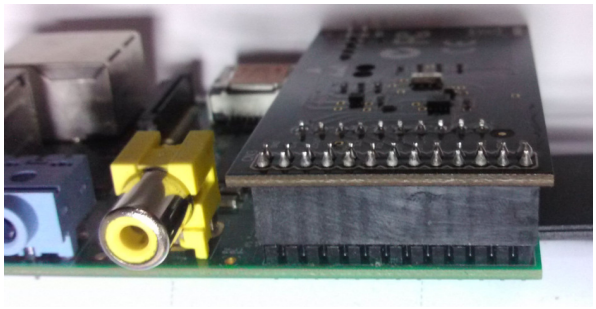
The final section includes details on how a user can modify the standard default Raspberry Pi image in order to use the I2C connection to run the same terminal and web application demonstrations.

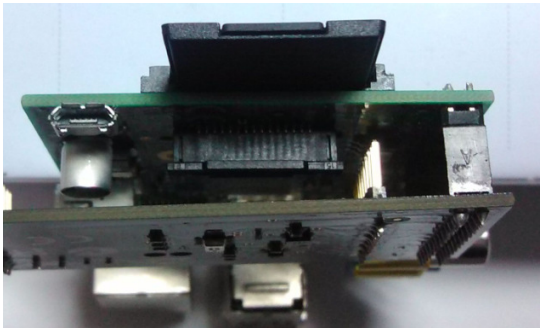
NOTE: The setup and terminal demonstration tests covered in steps 1 thru 7 (below) are also provided in the QuickStart Guide. A QuickStart Guide fold-out accompanies the XTRINSIC-SENSE BOARD kit and is also available on-line here:

Setup and Configuration

1. Connect the XTRINSIC-SENSE BOARD to the Raspberry PI board as shown below.



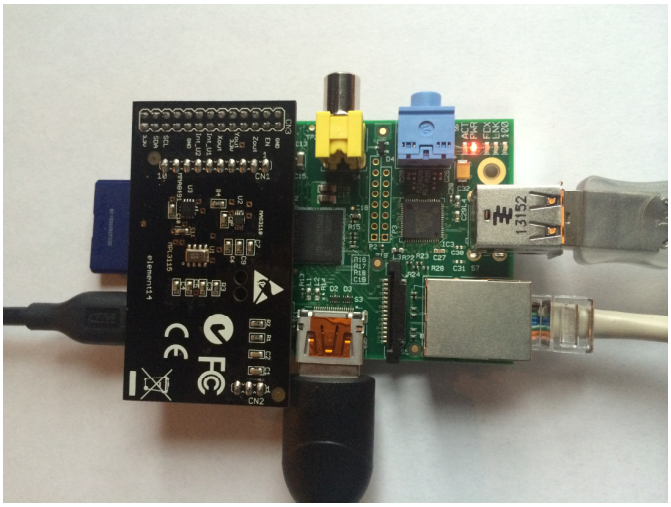




2. Download the custom operating system image offered and flash it to an SD card (4MB+). The custom Image for use with XTRINSIC-SENSE BOARD is available here:

   http://www.element14.com/mems_sense

3. Power on Raspberry Pi with a USB cable connection (as shown). Provide additional connections for needed peripherals.



4. Once in Raspberry Pi console mode enter in username (**`pi`**) and password (**`raspberry`**).

Sensor Terminal Tests

These following tests are run by executing python demo scripts *(described here)*:

- **mag3110.py**
  Test the Xtrinsic MAG3110 three-Axis, digital magnetometer, console will output the three-axis magnetometer value. *(The mag3110 can be calibrated by first running the mag3110_calibrate.py script. Calibration data will be stored in mag_calibration.data.)*

- **mpl3115a2.py**
  Test the Pressure/Altitude and Temperature, console will output the Temperature and Pressure/Altitude.

- **mma8491q.py**
  Test the Xtrinsic MMA8491Q 3-Axis multifunction digital accelerometer, console will output the 3-axis accelerometer data.

5. Test the MAG3110 sensor by entering the following at the Raspberry Pi's terminal prompt:

```
pi@raspberrypi:~$ cd ~/rpi_sensor_board/
```


© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python mag3110.py
```

The expected console output will look similar to the following:

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python mag3110.py
-572 645 0
MAG3110:        X. -17 uT       Y. 20 uT        Z. -56 uT
MAG3110:        X. -17 uT       Y. 20 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 20 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 20 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 20 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 20 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 20 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 20 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 19 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 19 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 19 uT        Z. -57 uT
MAG3110:        X. -18 uT       Y. 18 uT        Z. -57 uT
```

Type “Ctrl+C” to exit test and get back to terminal prompt.

6. Test the MPLA3115A2 sensor by entering the following at the Raspberry Pi’s terminal prompt:

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python mpl3115a2.py
```

The expected console output will look similar to the following:

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python mpl3115a2.py
MPL3115:        Alt. -52.0      Temp: 21.192
MPL3115:        Alt. -52.0      Temp: 21.192
MPL3115:        Alt. -52.0      Temp: 21.192
MPL3115:        Alt. -52.0      Temp: 21.192
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.888    Temp: 21.176
MPL3115:        Alt. -51.2      Temp: 21.176
```

Type “Ctrl+C” to exit test and get back to terminal prompt.

7. Test the MMA8491Q sensor by entering the following at the Raspberry Pi’s terminal prompt:

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python mma8491q.py
```

The expected console output will look similar to the following:

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python mma8491q.py
MMA8491Q:       X. -310 mg      Y. -16 mg       Z. 996 mg
MMA8491Q:       X. -129 mg      Y. -22 mg       Z. 1051 mg
MMA8491Q:       X. -135 mg      Y. -2 mg        Z. 1052 mg
MMA8491Q:       X. -139 mg      Y. -15 mg       Z. 1070 mg
MMA8491Q:       X. -131 mg      Y. -3 mg        Z. 1041 mg
MMA8491Q:       X. -138 mg      Y. -10 mg       Z. 1046 mg
MMA8491Q:       X. -109 mg      Y. -15 mg       Z. 1029 mg
MMA8491Q:       X. -127 mg      Y. -11 mg       Z. 1031 mg
MMA8491Q:       X. -137 mg      Y. -13 mg       Z. 1035 mg
MMA8491Q:       X. -154 mg      Y. 2 mg         Z. 1063 mg
MMA8491Q:       X. -127 mg      Y. -9 mg        Z. 1056 mg
MMA8491Q:       X. -135 mg      Y. -19 mg       Z. 1053 mg
MMA8491Q:       X. -148 mg      Y. -12 mg       Z. 1039 mg
```

Type “Ctrl+C” to exit test and get back to terminal prompt.

Sensor Web Application Tests

These following web application tests require the Raspberry Pi to have network connection to the same network as an available PC’s local area network (LAN).

8. Once the Raspberry Pi is network connected obtain the IP inet address using the ifconfig command:

```
pi@raspberrypi:~$ ~/rpi_sensor_board $  ifconfig
```

The expected terminal display will similar to the following:

```
eth0      Link encap:Ethernet  HWaddr b8:27:eb:95:5c:56
          inet addr:192.168.2.138  Bcast:255.255.255.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:5644 errors:0 dropped:0 overruns:0 frame:0
          TX packets:3620 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
```

*NOTE: In this example case the Raspberry Pi’s IP address is: **192.168.2.138**. We will use this example IP address in the rest of the demo examples described below. For your testing use the IP address found for your specific case in place of this IP address.*

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

9. Upload the sensor data to the web application (invoked later on a network connected PC) by entering the following at the Raspberry PI's terminal command prompt:

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python3 sensor_website.py
```

Console output:

```
pi@raspberrypi:~/rpi_sensor_board$ sudo python3 sensor_website.py
Input your choice for sensor
 1. mag3110
 2. mpl3115
 3. mma8491
 0. exit
Your choice:
```

Compass Application

10. Choose 1 to test the MAG3110. Note the console output:

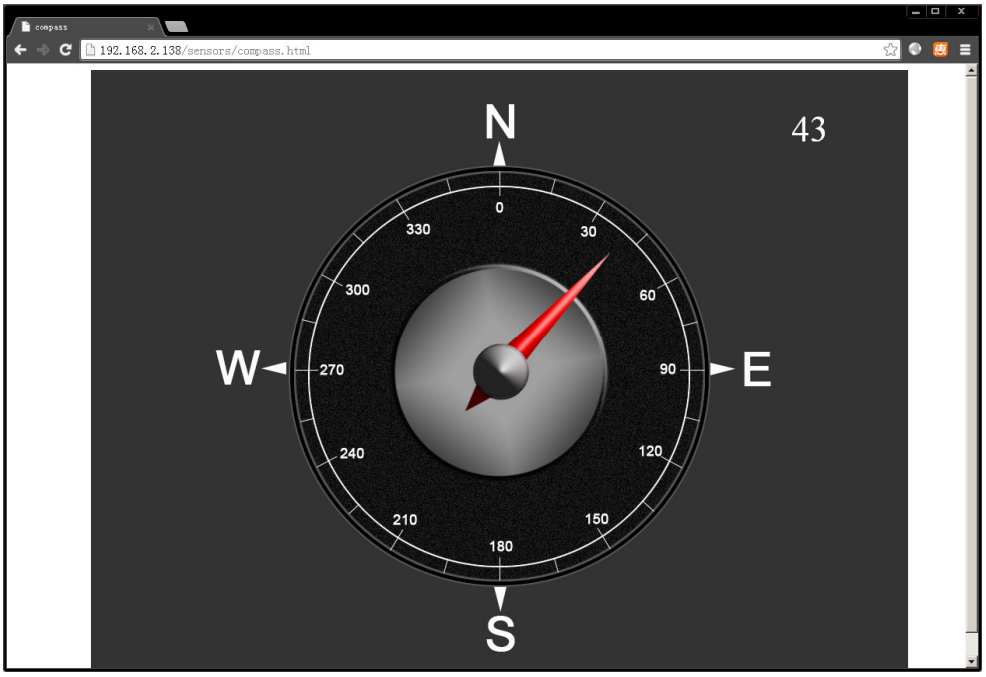
```
Your choice: 1
=================================================================
mag3110 sensor data will upload to compass.html
Use browser to open http://<rpi IP>/sensors/compass.html
Horizontally rotate your board, you can see the compass rotation
=================================================================
Your choice:
```

11. On a network connected PC, open a browser and enter in web address as instructed above. For this example that would be:

http://192.168.2.138/sensors/compass.html

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

12. The following should be displayed in the PC's browser:



Manually rotate the Raspberry Pi board to see corresponding movement on the compass display.

****

Tip *(optional)*

13. If the compass direction does not appear accurate, try calibrating using the following steps:

Enter in the following at the command prompt:

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python mag3110_calibrate.py
```

Console output:

```
pi@raspberrypi ~/rpi_sensor_board $ sudo python mag3110_calibrate.py

Calibrate your mag3110 sensor, Now horizontally rotate your board for 360 degrees

If you have done, press 0 to exit:
```

14. After exiting the calibration mode, try manually turning the Raspberry Pi board again and note the compass direction indicated in the PC browser's display. Check for better accuracy.

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Temperature Application

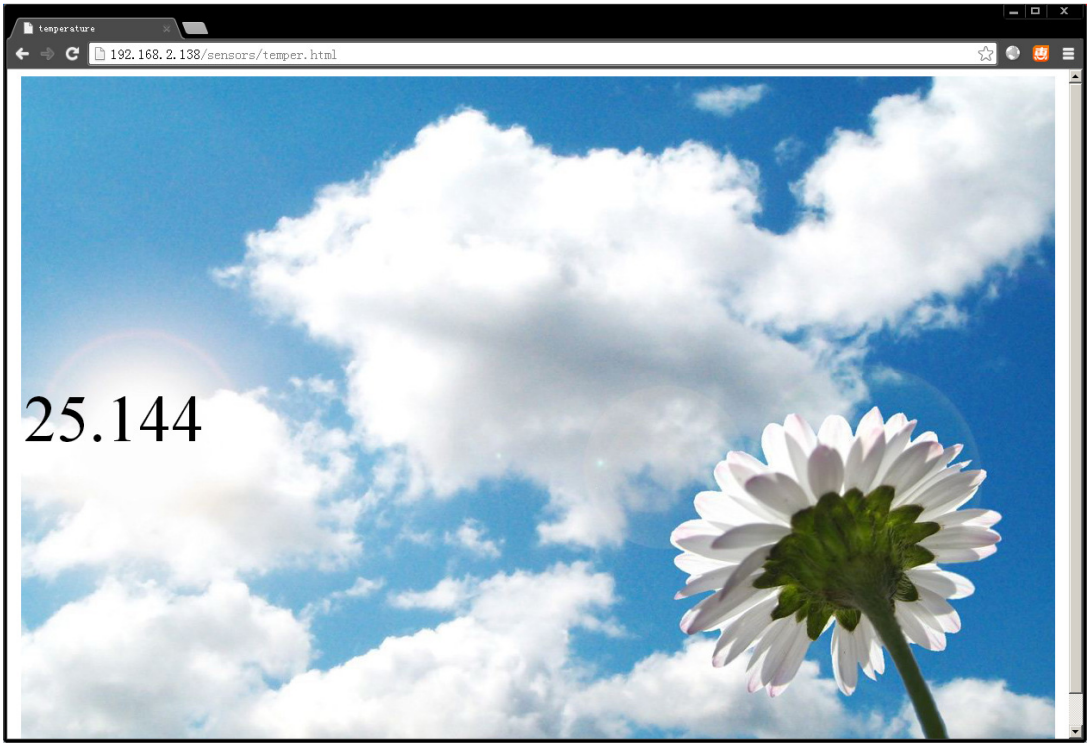
15. At the Raspberry Pi's console output choose **2** to test the MPL3115. The console output should display the following output:

```
Your choice: 2
================================================================
mpl3115 sensor data will upload to temper.html
Use browser to open http://<rpi IP>/sensors/temper.html
Touch your sensor board, you can see temperature value
================================================================
Your choice:
```

16. Re-direct the network connected PC's browser to the web address indicated above. For this example that would be:

    http://192.168.2.138/sensors/temper.html

17. The following should be displayed in the PC's browser. The temperature is displayed digitally in degrees C. For example, **25.144**° C. Touching or blowing on the MPL3115 (refer to Figure 1) should cause the temperature displayed to change.



© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Running Car Application

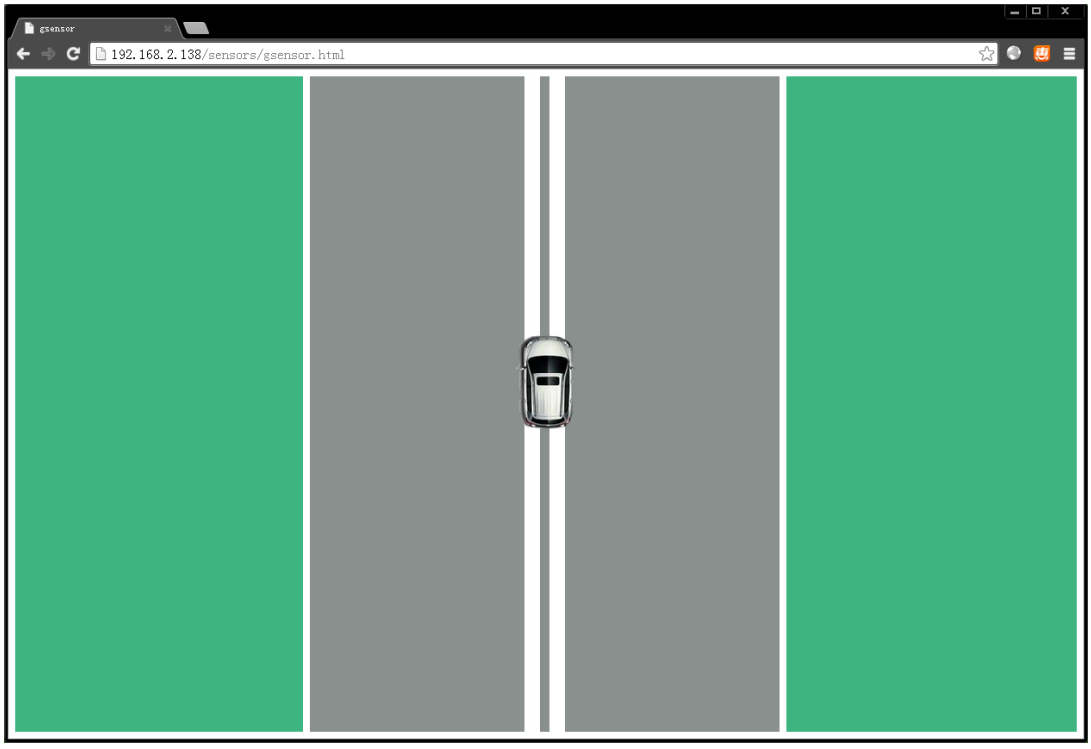
18. At the Raspberry Pi's console output choose **3** to test the MMA8491. The console output should display the following output:

```
Your choice: 3
================================================================
mma8491 sensor will upload to gsensor.html
Use browser to open http://<rpi IP>/sensors/gsensor.html
The small car on the web will be controled by the board.
Vertical and horizontal rotation will move the car correspondingly
================================================================
Your choice:
```

19. Re-direct the network connected PC's browser to the web address indicated above. For this example that would be:

    http://192.168.2.138/sensors/gsensorr.html

20. The following should be displayed in the PC's browser. Move and tilt the Raspberry Pi board to affect position of the car displayed on the screen.



21. Enter a choice of **0** or Ctrl-C to exit the testing.

This completes the terminal and web application demonstration tests for the XTRINSIC-SENSE BOARD with Raspberry Pi.

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Make your own RPi image to support XTRINSIC-SENSE BOARD connection

The following sections provide instructions for editing and constructing a Raspberry Pi Flash image starting with an official RPi image file. The instructions include details on how to manually update an official RPi image to support the same terminal and web applications demonstrations detailed in steps 5 thru 21 above.

This section assumes user knowledge on accessing an official RPi image and programming it to Flash. This detail is NOT covered in this document.

Set-up

22. Follow step 1, 3 and 4 in the previous section to set-up, connect, and power the Raspberry Pi with XTRINSIC-SENSE BOARD.

Terminal tests

The XTRINSIC-SENSE BOARD communicates with the Raspberry Pi using the I2C interface. The I2C interface driver is included in later Raspbian distributions but is not enabled by default. You can always enable the I2C driver, or you can load it by hand when required. To always enable the I2C driver:

23. After logging into RPi, edit `/etc/modprobe.d/raspi-blacklist.conf` by typing:

```
$ sudo nano /etc/modprobe.d/raspi-blacklist.conf
```

24. Insert a hash(#) at the start of the line blacklist i2c-bcm2708, it should be read:

```
# blacklist i2c-bcm2708
```

Alternatively, to load the I2C driver by hand (will not be loaded on reboot):

Ctrl-X to save

25. Type in a terminal:

```
$ sudo modprobe i2c-bcm2708
```

26. Next, you need to install the sensor drivers. Download the driver and python test scripts from:

```
git clone http://git.oschina.net/embest/rpi_sensor_board.git
```

27. When the downloading finished, reboot your Raspberry Pi:

```
$ sudo reboot
```

28. Then you can test the sensor from terminal. Refer to steps 5 thru 7 above to run terminal demonstration tests.

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Web application tests

29. Install the web server:
    - Install nginx web server, by typing:
      ```
      sudo apt-get install nginx
      ```
    - Start the nginx web server, typing:
      ```
      sudo /etc/init.d/nginx start
      ```

    The defualt server root is: `/usr/share/nginx/www`

30. Install the php package:
    - Install php, by typing:
      ```
      sudo apt-get update
      sudo apt-get install php5-fpm
      ```
    - Edit the config file of nginx
      ```
      sudo nano /etc/nginx/sites-available/default
      ```
    - Find the line start with *# listen 80*, delete the hash(#) , it should be read:
      ```
      listen 80; ## listen for ipv4.
      ```
    - Find the line start with *index*, add index.php, then it should be read:
      ```
      index index.php index.html index.htm
      ```
    - Find the definition of php, only delete the hashs(#) ahead of the following lines, it should be read:
      ```
      location ~ \.php$ {
      fastcgi_pass unix:/var/run/php5-fpm.sock;
      fastcgi_index index.php;
      include fastcgi_params;
      }
      ```

      Do not touch the other definitions.

31. Now, reload the config of **nginx** server:
    - ```
      sudo /etc/init.d/nginx reload
      ```

32. Test if the web server is up by browser. Should see something like the following screen:

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.
      ```

33. Deploying the Web Application
    - Direct use symbolic links (created via ln-s) to complete the deployment, typing:

```
sudo ln -s
/home/pi/rpi_sensor_board/Rpi_Xtrinsic_Sensors/rpi_sensors_web/
/usr/share/nginx/www/sensors
```

    - Make proper access rights to the web app:

```
sudo chmod 0777 -R
/home/pi/rpi_sensor_board/Rpi_Xtrinsic_Sensors/rpi_sensors_web/
```

34. Test the Web applications in the same manners as described in steps 8 thru 21 above.

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Hardware

This document includes the hardware design files for the XTRINSIC-SENSE BOARD on the following pages of this document.

Details on the supported host platforms can be found as noted below,

- For the Freescale FRDM-KL25Z board, please refer to:
  http://www.element14.com/community/docs/DOC-46626

- For the Raspberry Pi board please refer to:
  http://www.element14.com/community/docs/DOC-42993/l/raspberry-pi-single-board-computer

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Schematic

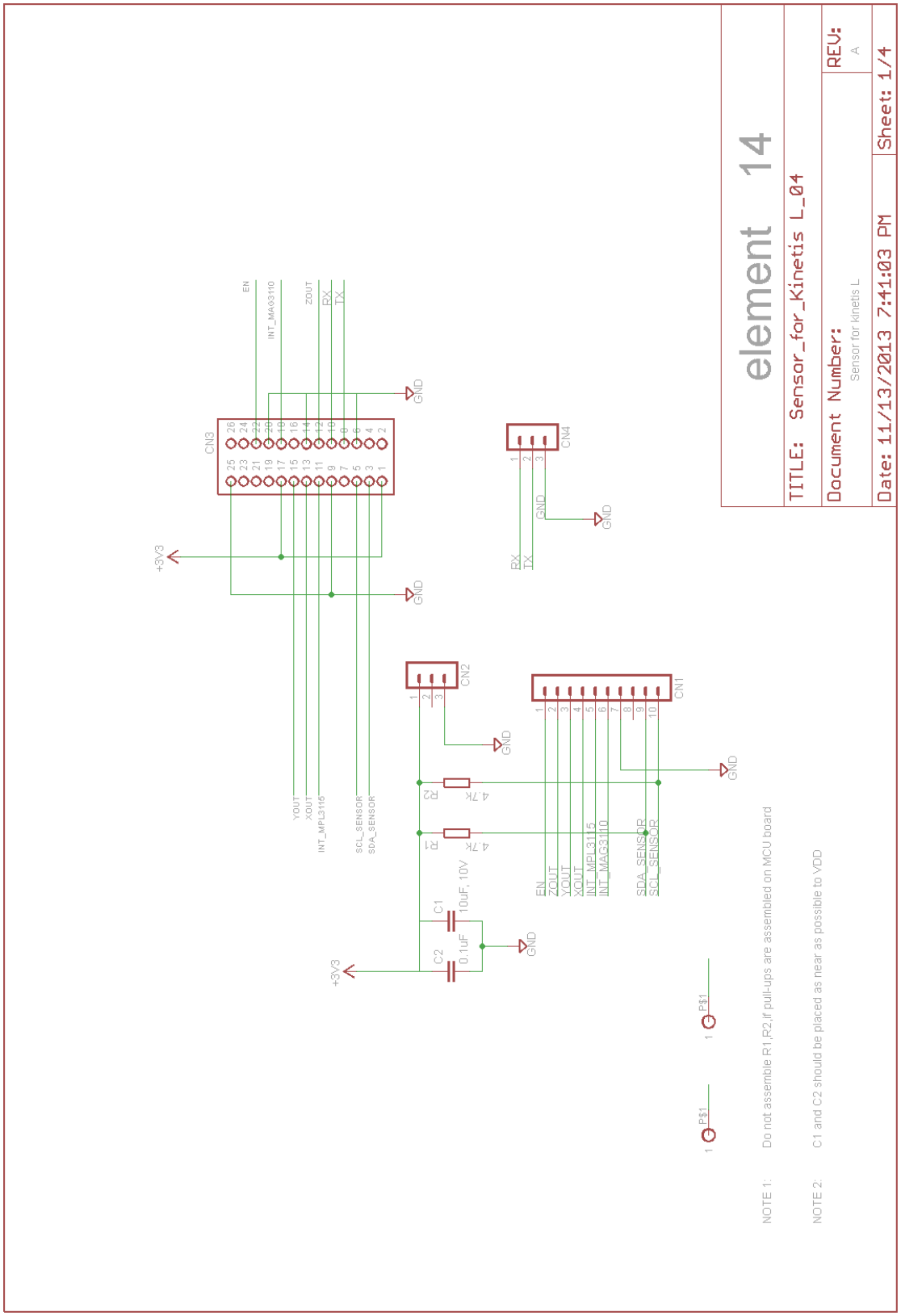


Figure 12 - Sensor Board Schematic - 1

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

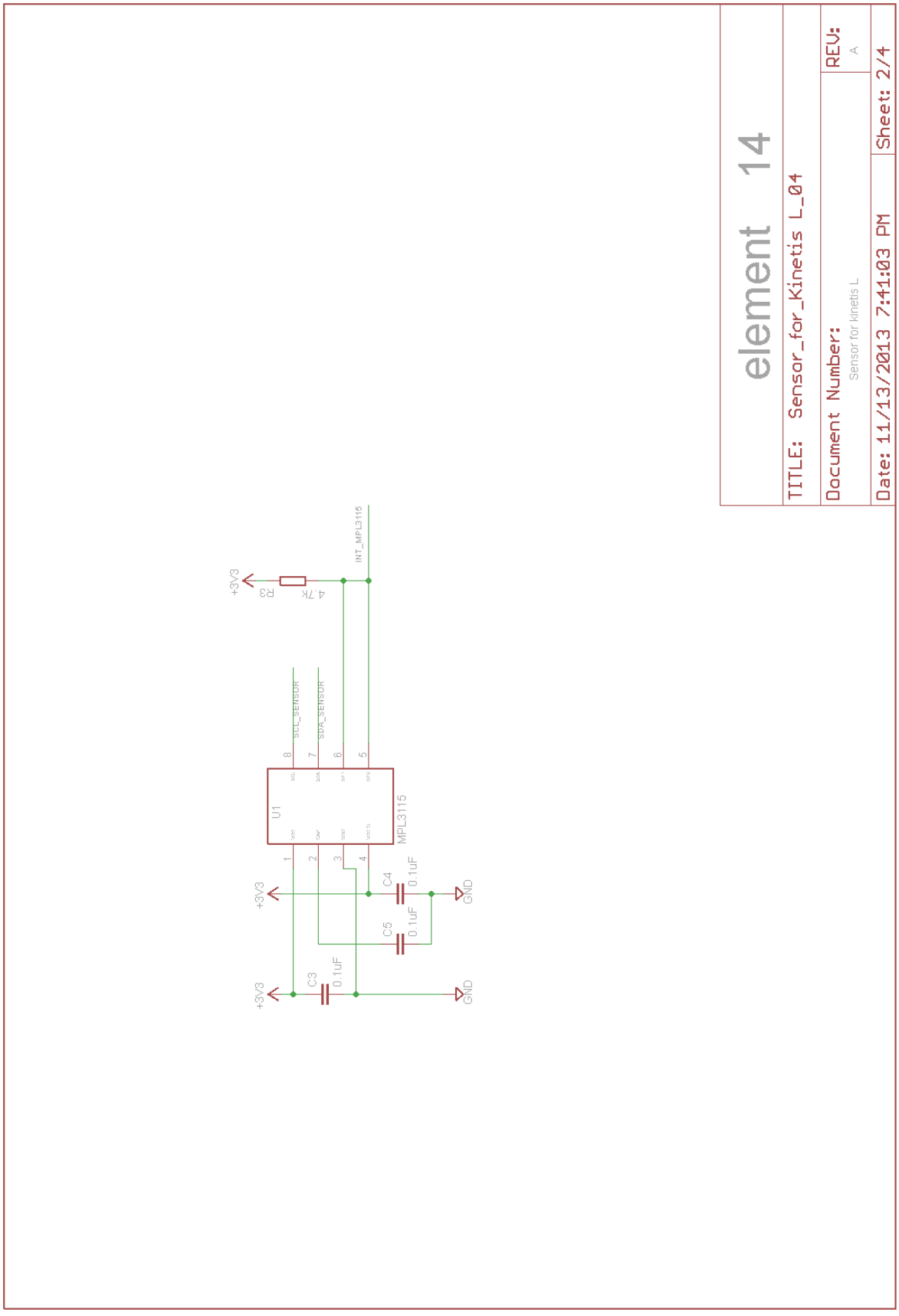


Figure 13 - Sensor Board Schematic - 2

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

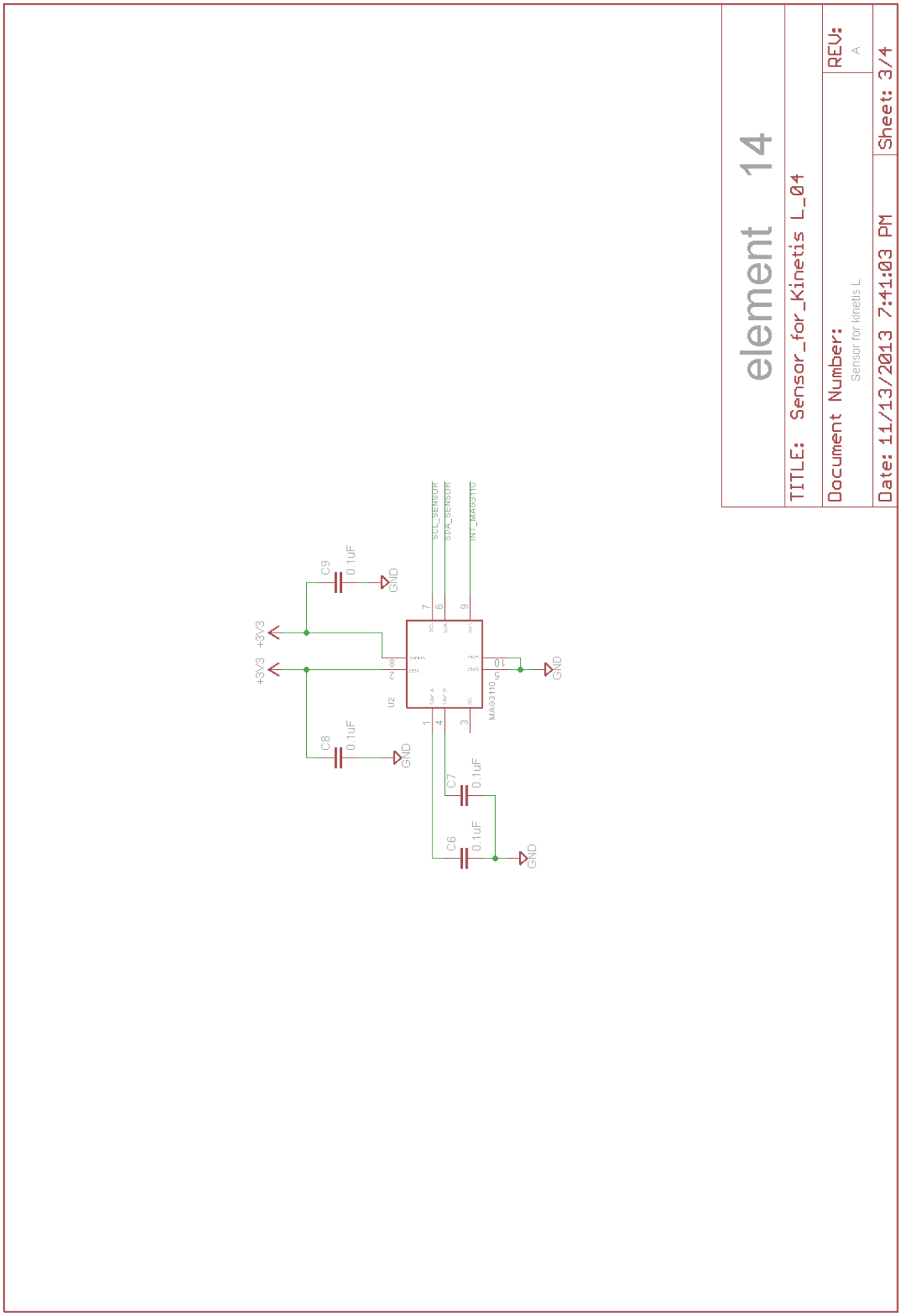


Figure 14 - Sensor Board Schematic - 3

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

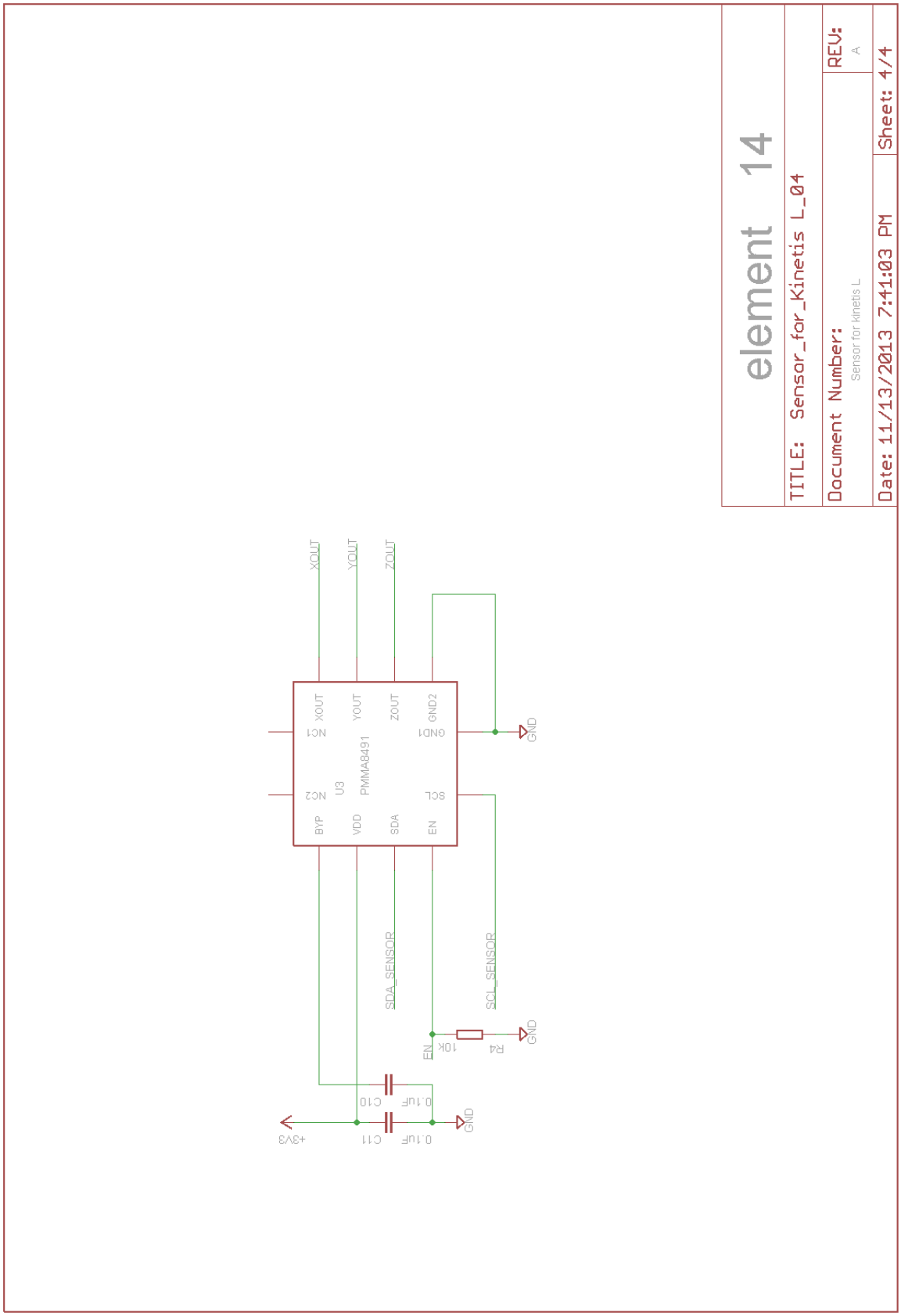


Figure 15 - Sensor Board Schematic - 4

© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

PCB Layout

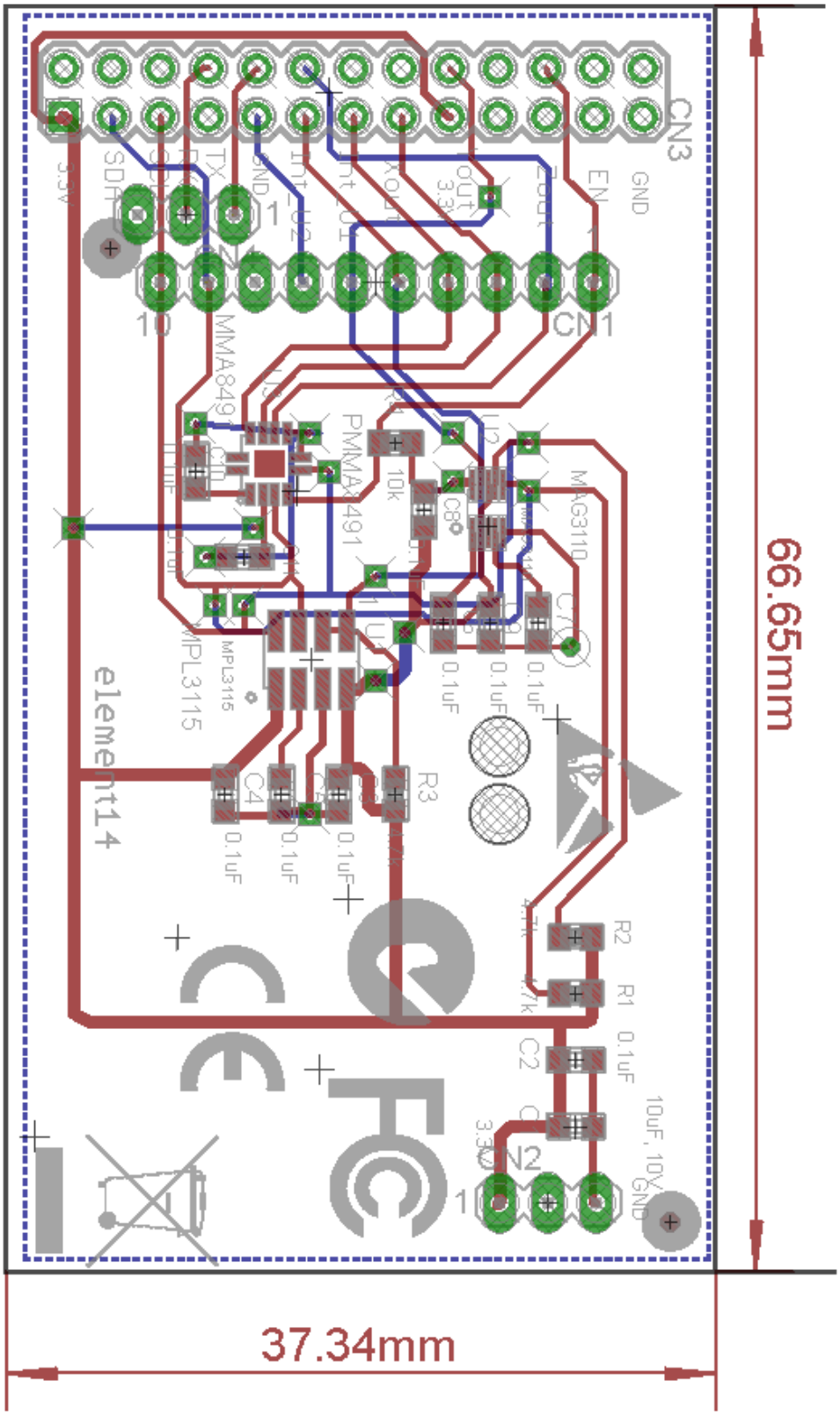


Figure 16 - Sensor Board PCB TOP View

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

Bill of Materials

Reference	Description	Manufacturer	Part No.	Farnell	Newark	Priority
U1	PRESSURE SENSOR, 20-110KPA					
		FREESCALE	MPL3115A2	2009084	61T7697	Preferred
U2	MAGNETOMETER, 3AXIS, I2C, 80HZ					
		FREESCALE	MAG3110FCR1	2080492	83T2982	Preferred
U3	ACCELEROMETER - SENSOR, QFN-16					
		FREESCALE	MMA8491Q	2291592	47W865	Preferred
C1	MLCC, 0603, 6.3V, 10UF					
		KEMET	C0603C106M9PACTU	1288201	86K0597	Preferred
		TAIYO YUDEN	JMK107BJ106MA-T	1463375	30K5476	Alternate
		AVX	QM036D106MAT	1867960	20T0206	Alternate
C2~ C11	MLCC, 0603, 16V, 0.1UF					
		AVX	CM105X7R104K16AT	1216538	01M7218	Preferred
		KEMET	C0603C104J4RACTU	1650834	64K2836	Alternate
		MULTICOMP	B0603R104KCT	9406140	37K9922	Alternate
R1, R2, R3	RESISTOR, 0603, 4.7K, 1%					
		MULTICOMP	MCHP03W8F4701T5E	1576293	01N6891	Preferred
		VISHAY	CRCW06034K70FKEA	1469807	52K8494	Alternate
		YAGEO	RC0603FR-074K7L	1117265	98K7410	Alternate
R4	RESISTOR, 0603, 10K, 1%					
		MULTICOMP	MCHP03W8F1002T5E	1576297	01N6844	Preferred
		VISHAY	CRCW060310K0FKEA	1469748	52K8063	Alternate
		YAGEO	RC0603FR-0710KL	1117235	68R0049	Alternate
CN1	HEADER, 2.54MM, VERTICAL THT, 10WAY					
		MOLEX	90120-0770	9733353	25M5816	Preferred
		SAMTEC	HTS-110-G-A	1929555	83T9016	Alternate
CN2, CN4	HEADER, 2.54MM, VERTICAL THT, 3WAY					
		TE	825433-3	3417657	99K0795	Preferred
		SAMTEC	HTS-103-G-A	1926586	83T8997	Alternate
CN3	HEADER, 2.54MM, 2x13					
			JT254-D180-850-213-001			

Table 28 - XTRINSIC-SENSE Board BOM list

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.

ESD PRECAUTIONS AND PROPER HANDLING PROCEDURES

This section includes the precautions for mechanical handling and static precautions to be taken to avoid ESD damage:

- Avoid carpets in cool, dry areas. Leave development kits in their anti-static packaging until ready to be installed.
- Dissipate static electricity before handling any system components (development kits) by touching a grounded metal object, such as the system unit unpainted metal chassis.
- If possible, use antistatic devices, such as wrist straps and floor mats.
- Always hold a evaluation board by its edges. Avoid touching the contacts and components on the board.
- Take care when connecting or disconnecting cables. A damaged cable can cause a short in the electrical circuit.
- Prevent damage to the connectors by aligning connector pins before you connect the cable. Misaligned connector pins can cause damage to system components at power-on.
- When disconnecting a cable, always pull on the cable connector or strain-relief loop, not on the cable itself.

Embest and element14 are trademarks of Premier Farnell plc
© 2014 Premier Farnell plc. All Rights Reserved
Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off.